FHWA COST ESTIMATE REVIEW

I-26 Widening

FHWA Cost Estimate Review

October 2018
Final Report

U.S. Department of Transportation
Federal Highway Administration

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EXECUTIVE SUMMARY

A review team consisting of the Federal Highway Administration (FHWA), the North Carolina Department of Transportation (NCDOT), and their consultants conducted a Cost Estimate Review (CER) workshop to review the cost and schedule estimates for State Transportation Improvement Program (STIP) Project Nos. I-4400/I-4700, I-26 Widening, which proposes widening I-26 from south of Hendersonville in Henderson County to south of Asheville in Buncombe County, NC (Chapter 1, Figure 1). The CER workshop was held June 5 to 7, 2018 at the NCDOT Century Center in Raleigh, North Carolina. Because a portion of the Project was determined to be unfunded during the close-out presentation, a revised model and close-out information were provided on June 26.

The objective of the review was to verify the accuracy and reasonableness of the Project's cost estimate and schedule; and to develop a probability range for the cost estimate that represents the Project's current stage of development. The purpose of the proposed I-26 Widening Project is to reduce congestion, with a goal of achieving an overall level of service (LOS) D in the design year (2040), and to improve the pavement structure. For construction purposes, the Project has been split into two primary projects and several sub-segments as follows:

- I-4400
  - I-4400A: I-26 Widening to 6-lanes from US 25 (Exit 54) to US 64 (Exit 49)
    - Currently unfunded in the 2018 – 2027 STIP but expect funding to be accelerated to July 2024.
  - I-4400BA: I-26 / US 64 (Exit 49) Interchange reconstruction only.
    - Funded in STIP for 2020.
  - I-4400BB: I-26 Widening to 6-lanes from US 64 (Exit 49) to US 25 (Exit 44).
    - Scheduled for award in June 2019 (contract combined with I-4400C)
  - I-4400C: I-26 Widening to 8-lanes from US 25 (Exit 44) to NC 280 (Exit 40)
    - Scheduled for award in June 2019 (contract combined with I-4400BB)
- I-4700
  - I-4700A: I-26 Widening to 8-lanes from NC 280 (Exit 40) to NC 146 (Exit 37)
    - Scheduled for award in June 2019 (contract combined with I-4700B)
  - I-4700B: I-26 Widening to 8-lanes from NC 146 (Exit 37) to NC 191 (Exit 33), including the Blue Ridge Parkway Bridge.
    - Scheduled for award in June 2019 (contract combined with I-4700A)

Of the planned projects, all but I-4400A are fully-funded as noted above. NCDOT expects to decide regarding funding of the unfunded portion later this year; however, for this report, FHWA has modeled two scenarios: 1) the Total Project (funded and unfunded) and 2) the Funded portions of the Project.

Prior to the CER workshop, the total project cost was estimated at $648M in current year (CY) dollars, and $731M in Year of Expenditure (YOE) dollars, with inflation included. This included funded and unfunded portions. The project completion date is March 2032. During the CER the review team identified adjustments to the base estimate that totaled a net cost increase of approximately $85M (see Chapter 3 for a listing of these adjustments).

In typical CERs, contingencies are removed from the base estimate and cost and schedule risks are identified, quantified, and then added to the base estimate. For this CER, the pre-CER workshop estimate included about $95M in contingencies that were removed from the base estimate to set the base cost in the Monte Carlo simulation model. Risks (both threats and opportunities) were added to this estimate and inflation rates were utilized to escalate costs to the midpoints of expenditure based on the projected schedule.

Following this process, the Monte Carlo simulation for the full Project resulted in a 70 percent confidence level at $761M YOE costs with the resultant range between confidence levels from 0 percent, or $673M, to 100 percent, or $833M, although these extremes are very unlikely to occur. The fully-funded portion of the Project (i.e. all but I-4400A) resulted in YOE costs of $627M. Design-bid-build (D-B-B) procurements were assumed for all contracts for this base Monte Carlo simulation.

An additional Monte Carlo simulation was run to determine the approximate annual delay cost if the full Project start is delayed by one year. This resulted in an approximate $23M annual cost of delay, which is almost entirely attributable to inflationary costs.

The following table summarizes the 70 percent confidence YOE results for these three Monte Carlo simulations, including showing a comparison to the previously mentioned Pre-CER estimate.

#	Description	Current Year Costs	YOE	Completion Date
1	Pre-CER	$ 647,645,596	$ 730,503,608	3/30/2032
2	CER 70% Result Total Project All Phases	$ 678,407,120	$ 761,452,702	4/30/2028
	Delta from Pre-CER (#2-#1)	$ 30,761,524	$ 30,949,094	-1430 days
3	CER 70% Result Funded Portion	$ 540,303,426	$ 627,094,923	7/15/2023
4	CER 70%f Result w/ 1 Year delay	$ 678,477,845	$ 784,851,283	4/29/2029
	Delta from CER (#4 - # 2)	$ 70,725	$ 23,398,581	12 months

This estimate is a snapshot in time that corresponds with the level of project development. As project development advances, such as design criteria refinement, final design, procurement activities, and future funding and scheduling decisions, this estimate will likely change.

Review findings/observations are as follows:

- The NCDOT and consultant Project Team was comprised of appropriate subject matter experts (SMEs).
- The Project Team demonstrated good coordination regarding the estimate.
- The SMEs understood the project elements well and were very engaged during the CER.
- During the review, the project's estimate of cost and schedule was updated to current data.
- The Project Team utilized prior CER experience to enhance the review.
- The Project Team is working to mitigate potential issues and risks.

The following recommendations are provided based on this review:

- Update the project estimate to reflect adjustments made during the review.
- Utilize the Risk Register resulting from this CER as a tool to continue managing the project's risks.
- Consider the adequacy of the risks in representing the current contingency.
- Utilize the results of the CER to inform the project's Initial Financial Plan (IFP).
- Continue strong coordination with FHWA-Eastern Federal Lands (EFL) and the National Park Service (NPS).
- Develop a process for coordination and resolution of issues across Divisions.

CHAPTER 1 – REVIEW PROCESS

A review team consisting of the Federal Highway Administration (FHWA), the North Carolina Department of Transportation (NCDOT), and their consultants conducted a Cost Estimate Review (CER) workshop to review the cost and schedule estimates for State Transportation Improvement Program (STIP) Project Nos. I-4400/I-4700, I-26 Widening, which proposes to widen I-26 from US 25 south of Hendersonville in Henderson County to I-40/I-240 south of Asheville in Buncombe County, North Carolina. The CER workshop was held June 5 to 7, 2018 at the NCDOT Century Center in Raleigh, North Carolina.

During the CER, NCDOT revised dates for some of the project sub-segments based on updated information, which anticipates an earlier overall project completion. At the close-out presentation on June 7, 2018, a NCDOT Division 14 representative clarified that a decision to fund the I-4400A phase would not be made until late in 2018 and confirmed that it was reasonable to assume the new completion dates for modeling. Therefore, the original close-out presentation was revised to reflect the funded/unfunded scenario and confirmed by NCDOT on June 27. Additional slides were added to show the revised ROW and Let dates, the YOE estimate range and schedule for the funded portion only, and added clarifying notes and re-titled slides previously labeled for the total Project to now read 'All Phases – Funded and Unfunded'. The revised forecasts for the funded phase will inform the Initial Financial Plan (IFP) since the funding decision on I-4400A may not be made until after the IFP is approved. The revised closeout presentation is included in the Appendices.

The purpose of this chapter is to provide a general overview of the CER process. This chapter includes a discussion of the review objective, team, documentation provided, and methodology.

REVIEW OBJECTIVE

The objective of the CER was to conduct an unbiased risk-based review to verify the accuracy and reasonableness of the current total cost estimate to complete the Project and to develop a probability range for the cost estimate that represents the current stage of Project design. The review team also reviewed the proposed Project schedule to determine potential schedule impact on the Project cost.

BASIS OF REVIEW

The Moving Ahead for Progress in the 21st Century Act (MAP-21) required the financial plan for all Federal-aid projects with an estimated total cost of $500M or more to be approved by the U.S. Department of Transportation Secretary (i.e. FHWA) based on reasonable assumptions. This requirement has remained in place with the current Fixing America's Surface Transportation (FAST) Act. The $500M threshold includes all project costs, such as engineering, construction,

ROW, utilities, construction engineering, and inflation. The FHWA has interpreted 'reasonable assumptions' to be a probabilistic risk-based analysis. The CER provides this risk-based assessment and is used in the approval of the financial plan. This is an independent review but does not use an independent FHWA estimate. The review team used an estimate provided by the NCDOT project team.

REVIEW TEAM

The review team was selected with the intent of having individuals with a strong knowledge of the Project and/or of Major Project work and expertise in specific disciplines of the Project. This team participated together throughout the workshop and individuals with specific Project expertise briefed the review team on portions of the Project or estimate development processes. The review team also discussed the development of the Project cost estimate quantities, unit prices, assumptions, opportunities, and threats. Sign-in sheets are provided in the Appendices.

The review team was comprised of members of the following organizations:

- FHWA
  - Division Office
  - CER Cadre Team - FHWA Resource Center
  - Eastern Federal Lands
- NCDOT
  - Project Team
  - Consultants

DOCUMENTS REVIEWED

Documents provided for review prior to and during the workshop included:

- Project Cost Estimate and Schedule
- Draft Risk Register
- Project Presentation
- Project website
- Current project maps and drawings

METHODOLOGY

The methodology for this CER is outlined as follows:

- Verify accuracy of cost estimate
  - Understand project scope and cost estimate development process
  - Discuss assumptions for contingencies and projected inflation rates
  - Review major cost elements
  - Identify threats and opportunities (Risks)
- Model uncertainties

- Establish base estimate variability
- Model variation of inflation
- Determine probability of occurrence and schedule and cost impacts for significant project threats and opportunities
- Model anticipated market conditions at the time of procurement

- Perform Monte Carlo simulation to model variability and risks and generate likely range of project cost and schedule
- Communicate results
  - Report methodology and results in a close-out presentation
  - Document review in a final report that will be used to inform the public and develop the financial plan

The following discussion provides more detail about the concepts utilized during the review.

Verify Accuracy of Cost Estimate

The review team was provided an overview of the estimation process used to develop the Project's estimate. This overview included a discussion on the scope of the Project, stage of design, and assumptions used to develop the estimate. The review team interviewed the project team and discussed the accuracy of each major cost element.

Model Uncertainties

In general, uncertainties in the estimate can be described as those relating to base variability, market risks, and cost and schedule risk events. Each of these are discussed and modeled to reflect the total uncertainty.

Base variability is a measure of uncertainty applied to the base estimate that represents the inherent randomness associated with the estimating process. Base variability is a function of the Project's current level of design and the process used to develop the estimate. This may be demonstrated by the fact that two estimators using the same data source and following the same general estimate development guidance will generate different estimates. Additionally, the lack of details about the Project and assumptions that should be used to develop the estimate would cause more uncertainty and variability in the estimate. This base variation is a function of the system (i.e. assumptions and data sources used to define the estimate). Base variability is applied to the base estimate exclusive of risks. Contingencies that include risks are removed from the base estimate to avoid double counting risks identified in the Risk Register. Allowances and expected construction change order costs typically remain in the base estimate.

Market conditions at the time of advertisement are modeled to reflect the future competitive bidding environment. Three scenarios are evaluated including worse than planned, as-planned, and better than planned. Each scenario is assigned a likelihood of occurrence and range of

associated costs. In addition to market conditions, inflationary risk is also modeled and used to Project current year dollars to year of expenditure.

A risk register is developed by interviewing the Project Team to define the components of contingency and establish both cost and schedule risks. The risk register includes the event risk name, a description of the event, a probability measure of the likelihood the event will occur, as well as a probability distribution of costs if the event were to occur. The register also identifies if the risk event is a threat or opportunity for cost/schedule. Risk threats increase costs/schedule and opportunities decrease costs/schedule. A very important feature of the risk register is to establish the relationship of risk events. For example, some risks are mutually inclusive or mutually exclusive. Mutually inclusive means the risk event can only occur if the prior risk event occurs. Conversely, for a risk event to be mutually exclusive means that it can only occur if the prior risk event does not occur. Risk events can also be independent, in which case the probability of occurrence is not dependent on any other risk event. Correlation determines how one risk event will sample relative to another risk event. Correlation should only be established when there is reason to suspect that a relationship exists and needs to be accounted for in the simulation.

After models are developed for market conditions, base variability, and risk events, the review team utilized a Monte Carlo simulation to generate a probability-based estimate of YOE Total Project Costs. A Monte Carlo simulation is essentially a rigorous extension of a "what-if" statement, or sensitivity analysis, that uses randomly selected sets of values from the probability distributions representing uncertainty to calculate separate and discrete results. A single iteration within a simulation is the process of sampling from all input distributions and performing a single calculation to produce a deterministic result. It is important that each iteration represent a scenario, or outcome, that is logically possible. It is for this reason that the simulation outcomes be reviewed to ensure accuracy. The process of sampling from a probability distribution is repeated until the specified number of computer iterations is completed or until the simulation process converges. Simulation convergence is that point at which additional iterations do not significantly change the shape of the output distribution. The results of the simulation are arrayed in the form of a distribution covering all possible outcomes. The key benefit of this process is that probability is associated with costs.

Communicate Results

The final part of the review is to communicate the review results by providing a closeout presentation and final report. At the end of the review, the review team provides a closeout presentation that summarizes the review findings. The presentation identifies the review objectives and agenda, discusses the methodology, and highlights the results of the review including the pre/post-workshop estimate results and any estimate adjustments made during the

review. The closeout presentation also identifies any significant cost and schedule risks, and provides a brief overview of recommendations by the review team. The final close-out presentation for this review was provided on June 26, 2018 and is included in the Appendices.

The estimate review is a snapshot in time and as additional information becomes available it is expected that the estimate will change and be updated. Following review of the draft report, if errors or omissions are identified and confirmed with the project sponsor, these modifications will be incorporated into the final report. The final report communicates all findings of the review to the project sponsor and NCDOT and serves as the official document for the cost estimate review. Cost Estimate Review reports are maintained by the FHWA Office of Stewardship, Oversight and Management's Major Projects Team.

CHAPTER 2– REVIEW SUMMARY

PROJECT BACKGROUND & SCOPE

State Transportation Improvement Program (STIP) Project Nos. I-4400/I-4700, I-26 Widening, proposes widening I-26 from south of Hendersonville in Henderson County to south of Asheville in Buncombe County, NC (Figure 1). The purpose of the proposed I-26 Widening Project is to reduce congestion, with a goal of achieving an overall level of service (LOS) D in the design year (2040), and to improve the pavement structure. For purposes of construction, the Project has been split into two primary projects with sub-segments as follows (Table 1 also shows the segments and a basic schedule):

- I-4400 will improve 13.6 miles of I-26 beginning at US 25 (Exit 54) south of Hendersonville and extending along I-26 west to NC 280 (Airport Road) (Exit 40) in Henderson County.
  - I-4400A: Widen I-26 to six lanes from US 25 (Exit 54) to just east of US 64 (Four Seasons Boulevard/Chimney Rock Highway) (Exit 49)
    - Currently unfunded in the STIP, but is expected to be accelerated and let in July 2024.
  - I-4400BA: I-26 / US 64 (Exit 49) Interchange reconstruction only.
    - Funded in STIP for 2020.
  - I-4400BB: Widen I-26 to six lanes from US 64 (Exit 49) to US 25 (Asheville Highway) (Exit 44).
    - Scheduled for award in June 2019 (contract combined with I-4400C)
  - I-4400C: Widen I-26 to eight lanes from US 25 (Asheville Highway) (Exit 44) to NC 280 (Exit 40)
    - Scheduled for award in June 2019 (contract combined with I-4400BB)
- I-4700 will improve 8.6 miles of I-26 from NC 280 west to the I-40/240 interchange, south of Asheville, in Buncombe County. In addition to widening I-26, the Blue Ridge Parkway bridge over I-26 will also be replaced.
  - I-4700A: Widen I-26 to eight lanes from NC 280 (Exit 40) to NC 146 (Long Shoals Road) (Exit 37)
    - Scheduled for award in June 2019 (contract combined with I-4700B)
  - I-4700B: Widen I-26 to eight lanes from NC 146 to NC 191 (Brevard Road) (Exit , including the Blue Ridge Parkway Bridge.
    - Scheduled for award in June 2019 (contract combined with I-4700A)

Phase/Segment	Approx. % design	ROW Start	Letting
I-4400 A	15	July 2022	July 2024
I-4400 BA	15	June 2019	January 2020
I-4400 BB	15	Dec. 2018	June 2019
I-4400 C	15	June 2018	June 2019
I-4700 A	70	June 2018	June 2019
I-4700 B	70	June 2018	June 2019

Table 1: Project Phases/Segments and Basic Schedule

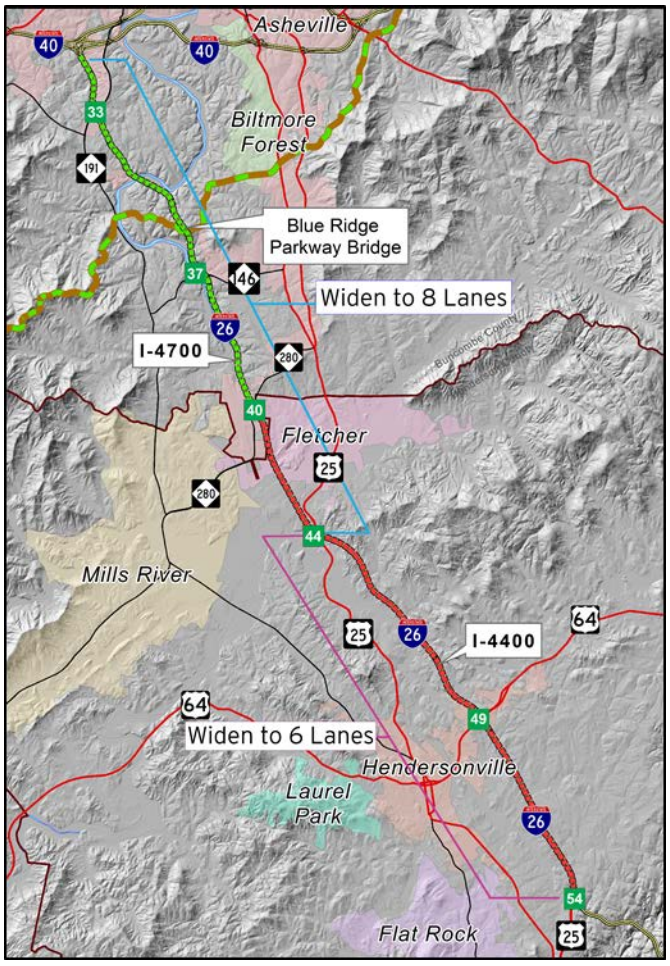

Figure 1: Project Limits and Preferred Alternative

ENVIRONMENTAL PROCESS

The combined Final Environmental Impact Statement (EIS)/Record of Decision (ROD) document is expected to be published in September 2018, which is the basis for the "Preferred Alternative" being analyzed in the CER. Following the release of the combined document, right of way

acquisition and permit submittals will begin to meet a planned construction start of the fully-funded projects in June 2019.

PROJECT PROCUREMENT

Design-Bid-Build (D-B-B) procurements are being planned and that delivery method was modeled for the base case CER Monte Carlo simulation.

A second Monte Carlo simulation was run to determine the approximate annual delay cost if construction and related items are delayed beyond the risks that were identified and modeled during the CER workshop.

PROJECT SCHEDULE

Table 2 shows the general schedule milestones that were used in the base case for the CER Monte Carlo simulation".

Segment	Description	Phase	Start	End
I-4700AB	Widen I-26 to 8 lanes east of NC 191 to NC 280, includes Blue Ridge Parkway bridge and French Broad River bridge	ROW/Utilities/Environmental Mitigation	6/19/2018	12/19/2019
		Agency/Construction/Landscaping	6/19/2019	3/30/2023
I-4400C/ I-4400BB	I-4400C - Widen I-26 to 8 lanes from NC 280 east to US 25 (Asheville Highway) I-4400BB - Widen I-26 to 6 lanes from US 25 (Asheville Highway) to just west of US 64	ROW/Utilities/Environmental Mitigation	6/19/2018	12/19/2019
		Agency/Construction/Landscaping	6/19/2019	3/30/2023
I-4400BA	US 64 interchange	ROW/Utilities/Environmental Mitigation	6/1/2019	10/17/2020
		Agency/Construction/Landscaping	1/15/2020	3/30/2022
I-4400A	Widen I-26 to 6 lanes from US 64 east to US 25	ROW/Utilities/Environmental Mitigation	7/16/2022	7/15/2024
		Agency/Construction/Landscaping	7/15/2024	3/30/2028

Table 2 - Project Schedule

COST ESTIMATE

Prior to the CER workshop, the total project cost was estimated at $648M in current year (CY) dollars, and $731M in YOE dollars, with inflation included. This included funded and unfunded portions. The project completion date is expected to be March 2032.

During the CER, the review team identified adjustments to the base estimate that totaled a net cost increase of approximately $85M. These are detailed in Table 3 demonstrating the impact on the CY estimate and the CY estimate that was loaded into the Monte Carlo model. Adjustments to the pre-CER schedule were also provided that influenced YOE inflation costs.

Subject Matter Experts (SMEs) on the Project Team identified these estimate adjustments. The Project Team has continued to refine cost information related to quantities and prices and has identified elements that will be part of the project costs.

Pre-CER Estimate incl contingency and priors		$ 647,645,596
Risk	**Type**	**Adjustment**
Causeway elevation at French Broad River	Schedule	2 Months
Accelerated Construction for 4400 A	Schedule	-42 Months
Blue Ridge Parkway Constructability Issues	Cost	$ 2,000,000
Updated pavement design (Thicker concrete paveme	Cost	$ 14,069,213
Expected increase in slope failures due to steeper slo	Cost	$ 2,702,339
Retaining walls related to geotect delays	Cost	$ 1,168,645
Added Rest area	Cost	$ 17,839,000
Temporary pavement for maintenance of traffic	Cost	$ 22,126,834
Phased temporary drainage installation cost	Cost	$ 1,816,750
Reduced Utility Transmission costs	Cost	$ (5,000,000)
Thicker subgrade stabilization	Cost	$ 8,402,088
Percentage Based Adjustments	Cost	$ 20,180,463
Total Net Adjustments		$ 85,305,332
Post Review Estimate (Current Year)		$ 732,950,928

Table 3: Base Cost Adjustments Identified During the CER

REVIEW FINDINGS / OBSERVATIONS

The following are the findings identified during this review:

- The Project Team was comprised of appropriate SMEs.
- The Project Team demonstrated good coordination regarding the estimate.
- The SMEs understood the project elements well and were very engaged during the CER.
- During the review, the Project's estimate of cost and schedule was updated to current data.
- The Project Team utilized prior CER experience to enhance the review.
- The Project Team is working to mitigate potential issues and risks.

REVIEW RECOMMENDATIONS

The following recommendations are provided based on this review:

- Update the project estimate to reflect adjustments made during the review.
- Utilize the Risk Register resulting from this CER as a tool to continue managing the Project's risks.
- Consider the adequacy of the risks in representing the current contingency.
- Utilize the results of the CER to inform the Project's Initial Finance Plan (IFP).
- Continue strong coordination with FHWA – Eastern Federal Lands (EFL) and the National Park Service.
- Develop a process for coordination and resolution of issues across Divisions.

CHAPTER 3 – RISK ANALYSIS

Cost estimates, especially those for Major Projects, contain a degree of uncertainty due to unknowns and risks associated with the level of detail design completed. For this reason, it is logical to use a probabilistic approach and express the estimate as a range rather than a point value. During the cost estimate review, uncertainties in the project estimate such as base variability, inflation, market conditions, and risk events were modeled by the review team to reflect the opinions of the subject matter experts interviewed. Then a Monte-Carlo simulation was used to incorporate the uncertainties into forecast curves that represent a range of costs and completion dates for the Project.

FORECAST RESULTS FOR TOTAL PROJECT COSTS

Figure 2 depicts the forecast curve for the total project cost in YOE dollars for the base-case procurement Monte Carlo simulation. The 70th percentile level of confidence that the estimate will not exceed $761.5M in total project cost is shown by the blue shaded area. Alternatively, these results predict a 30 percent probability that total project costs could exceed this value. All of the results in this section include prior costs of approximately $12.3M.

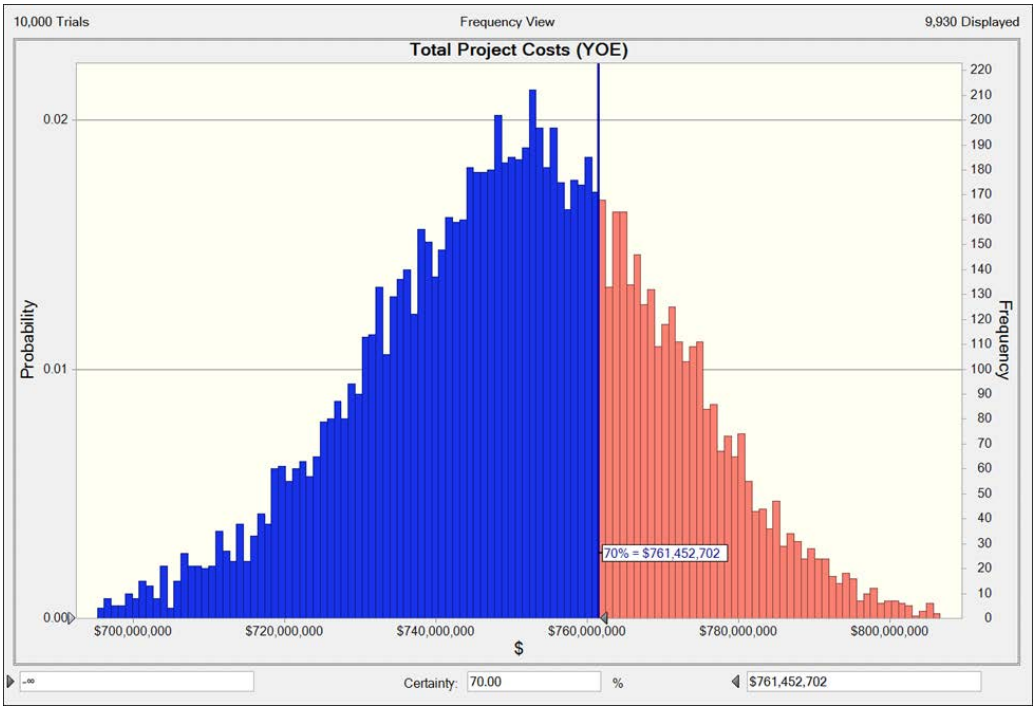

Figure 2: Probable Range of Total Project Costs Year of Expenditure (YOE dollars)

Table 4 demonstrates the YOE results of Figure 2 in a tabular range, showing that the project cost could range from $673.3M to $832.6M, although the lower and higher ends of the variance are unlikely. The higher end at the 100thpercentile reflects occurrences where all significant threats identified during the review will be realized, including those with a relatively low

likelihood, while opportunities would not be realized. The 70 percent result of $761.5M is within 5 percent of the pre-CER YOE cost estimate of $730.5M.

Percentile	Forecast values
0%	$673,306,891
10%	$725,334,457
20%	$734,515,744
30%	$741,024,049
40%	$746,491,595
50%	$751,424,768
60%	$756,089,779
70%	$761,452,702
80%	$767,611,727
90%	$775,724,820
100%	$832,572,923

Table 4: Percentile Rankings of Total Project Costs in YOE Dollars

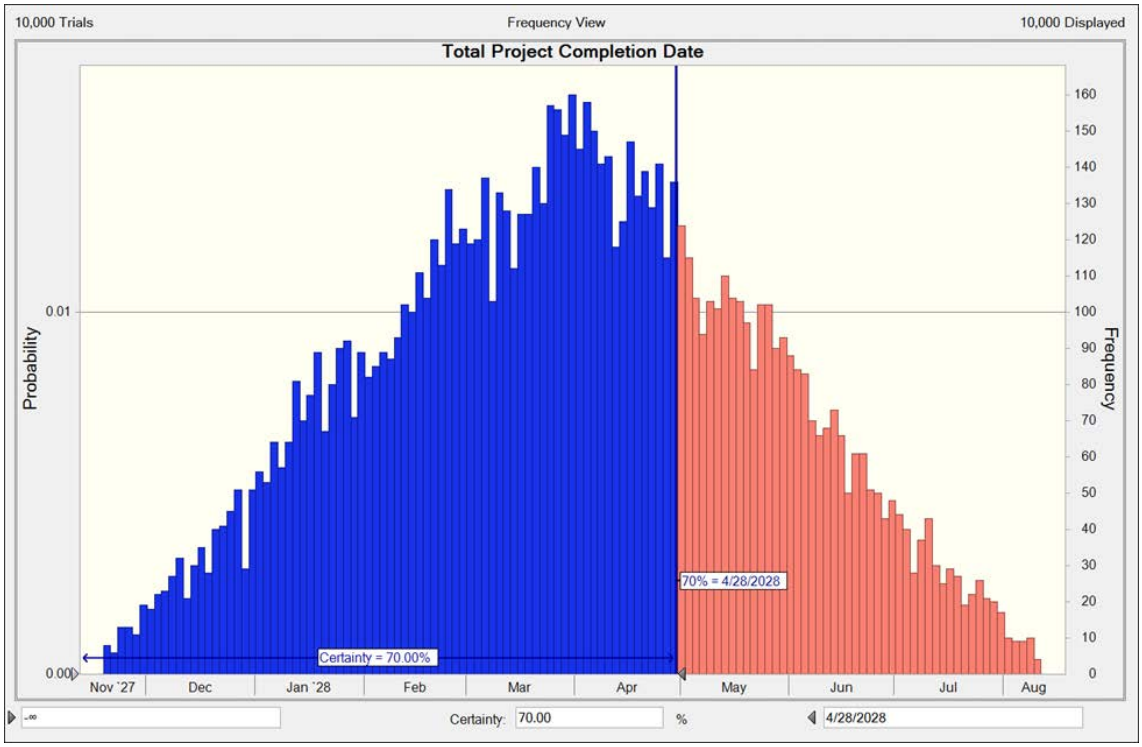

Figure 3: Project Completion Date

Figure 3 shows the results of the schedule risks on the project, with a projected completion date at 70 percent confidence level of April 28, 2028.

FORECAST RESULTS FOR FULLY-FUNDED PORTION OF PROJECT

The following Figure 4 demonstrates the total project YOE costs for the fully-funded portion of the project (i.e. all but I-4400A). The 70 percent YOE percentile level of confidence is at $627.1M.

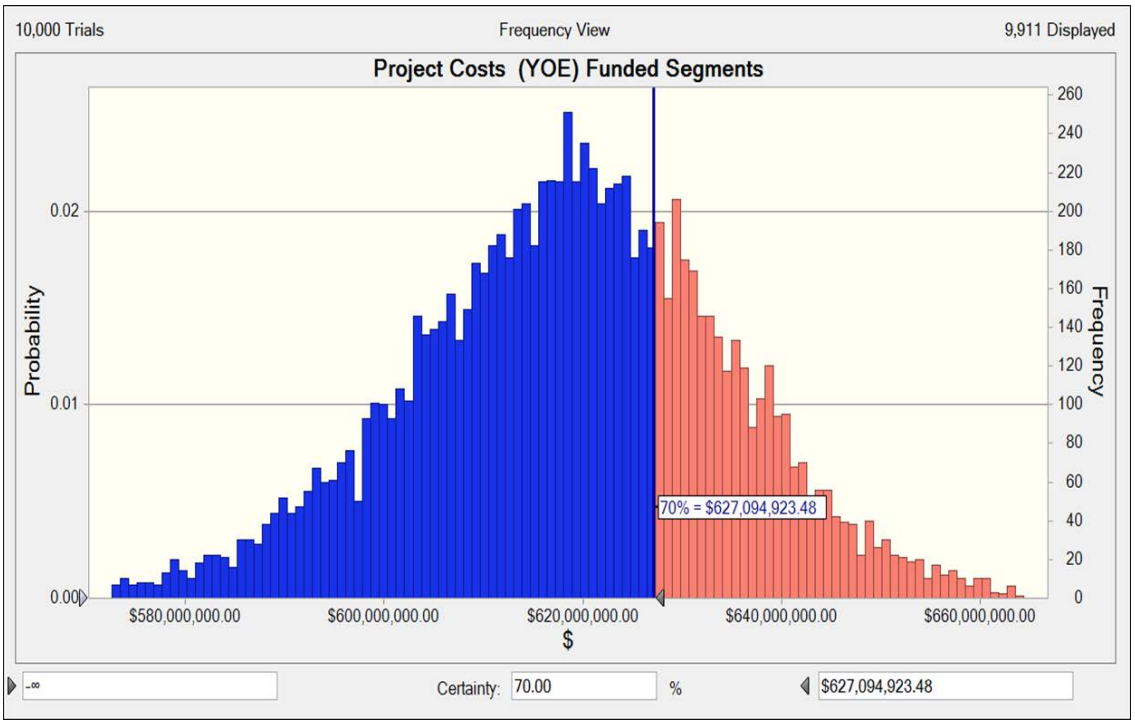

Figure 4: Probable Range of Costs for Fully-Funded Portion of Project (YOE dollars)

The difference between the 70 percent results for the total project versus the fully funded segments is approximately $134.4M, indicating that the future contract I-4400A has total costs of approximately this value.

Figure 5 shows a 70 percent forecast result for schedule completion of July 15, 2023. This chart demonstrates one important opportunity (i.e. maintaining access to the median throughout the I-4400C/I-4400BB projects) could allow the project to be completed sooner.

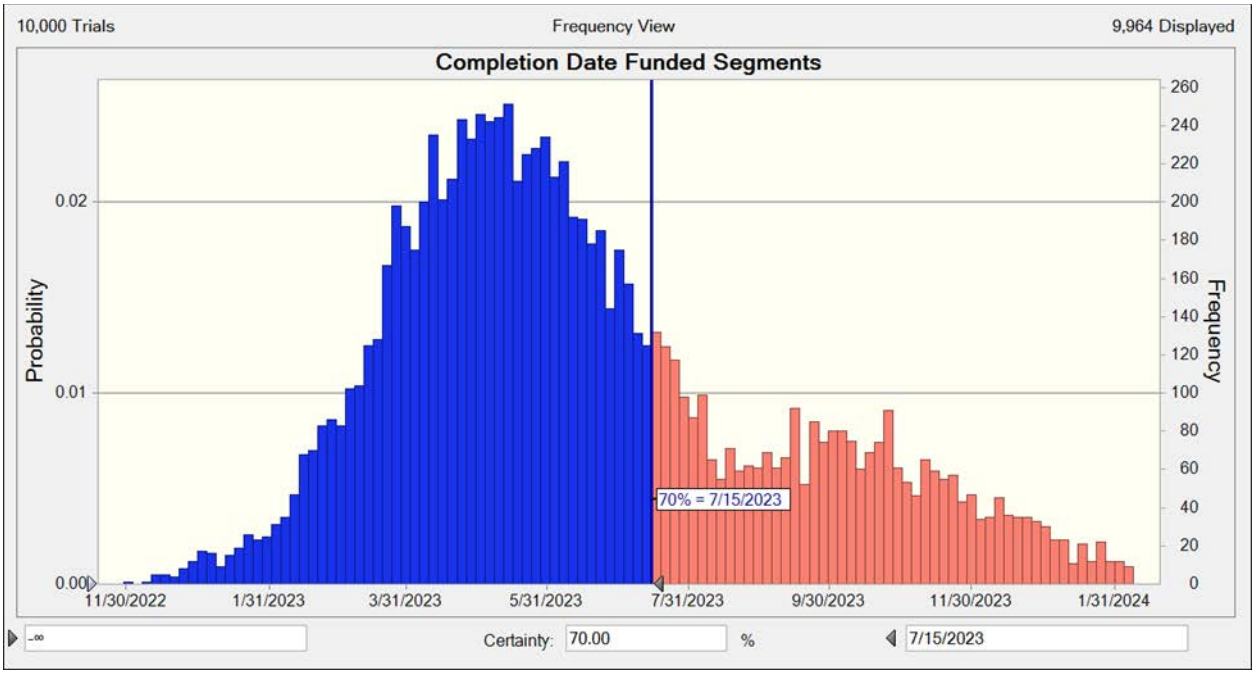

Figure 5: Probable Range of Total Project Completion Date for Fully-Funded Portion of Project

FORECAST RESULTS FOR 1-YEAR DELAY IN DBB PROCUREMENT

A second Monte Carlo simulation was run to determine the approximate annual delay cost if construction and related items are delayed beyond those identified and modeled during the CER workshop. Potential impacts that could contribute to a greater delay include extended collaboration with stakeholders and funding constraints. Modeling an additional potential one year of project delay for these potential impacts resulted in an approximate $23M annual cost of delay, which is almost entirely attributable to inflationary costs.

A comparison of this Monte Carlo simulation result, along with comparisons of the total project and fully funded portion simulation results, are shown in Table 5 in the next section.

SUMMARY OF THE MONTE CARLO SIMULATIONS

Table 5 summarizes the 70 percent confidence YOE results for the three Monte Carlo simulations, including a comparison to the pre-CER cost estimate.

#	Description	Current Year Costs	YOE	Completion Date
1	Pre-CER	$ 647,645,596	$ 730,503,608	3/30/2032
2	CER 70% Result Total Project All Phases	$ 678,407,120	$ 761,452,702	4/30/2028
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	Delta from CER (#4 - # 2)	$ 70,725	$ 23,398,581	12 months

Table 5: Comparison of Monte Carlo Simulation Results

Important to note is the total project result of $761.4M versus the one year delay value of $784.9M, a difference of $23.4M. This highlights the impact of inflation to the project should it be delayed beyond the current schedule

PROBABILITY ASSUMPTIONS

The assumptions discussed below describe how the review team modeled the risk events, base variability, inflation, and market conditions that served as inputs for the results shown in the previous section of this report. As discussed in Chapter 1, the Monte Carlo analysis selects random inputs from these distributions to determine discrete values for a given number of iterations. The model runs the simulation through 10,000 iterations and ranks the results to determine the likely range of cost and schedule for the project.

Risk - Threats and Opportunities

In a traditional cost estimate, risks are often accounted for by using a contingency percentage. For this CER, the pre-CER workshop estimate included about $95M in contingencies that were removed from the base estimate to set the base cost in the Monte Carlo simulation model.

During the review, a risk register was created, and discrete risk events were identified for the project to replace the contingency removed with more specific items that can be better managed and mitigated. The review team identified and discussed risks to the project in terms of threats and opportunities. For purposes of this review, a threat is a risk event that can add to the cost and/or schedule of the project and an opportunity is an event that can reduce the cost and/or shorten the schedule.

Risk events are quantified by likelihood of the occurrence and impact if it occurs. For example, Figure 6 shows a 50 percent risk likelihood, meaning that 50 percent of the 10,000 simulations will have this risk included. Figure 7 shows an example cost threat impact triangular distribution. When paired with the 50 percent risk likelihood, would mean that for 50 percent of the Monte Carlo simulations where this risk is triggered, it will randomly select a cost from this triangular distribution, with more frequent sampling near the most likely cost amount.

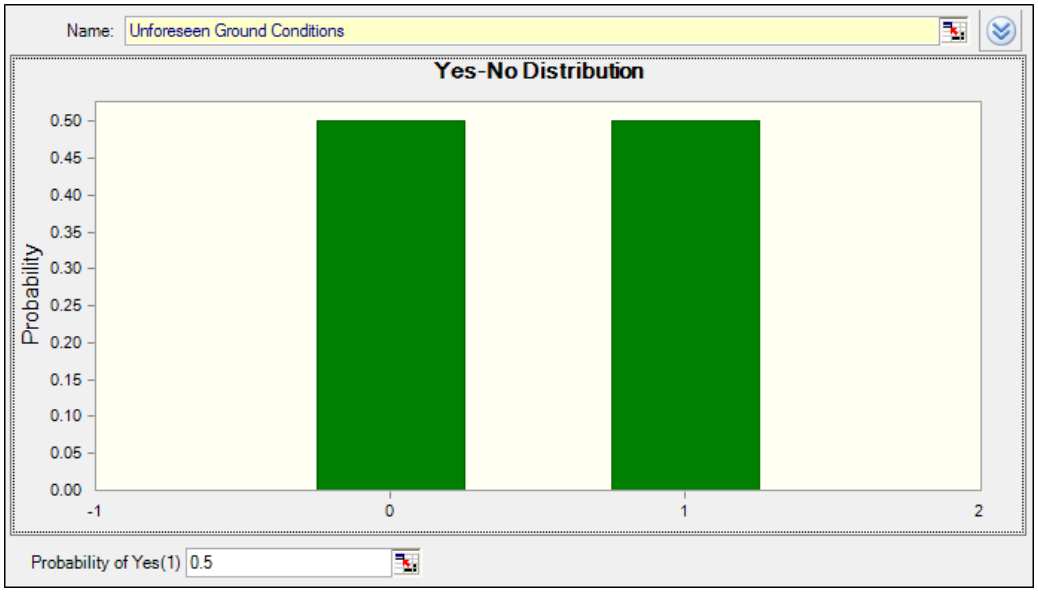

Figure 6: Example of Binomial Distribution for a Project Risk's Likelihood of Occurrence

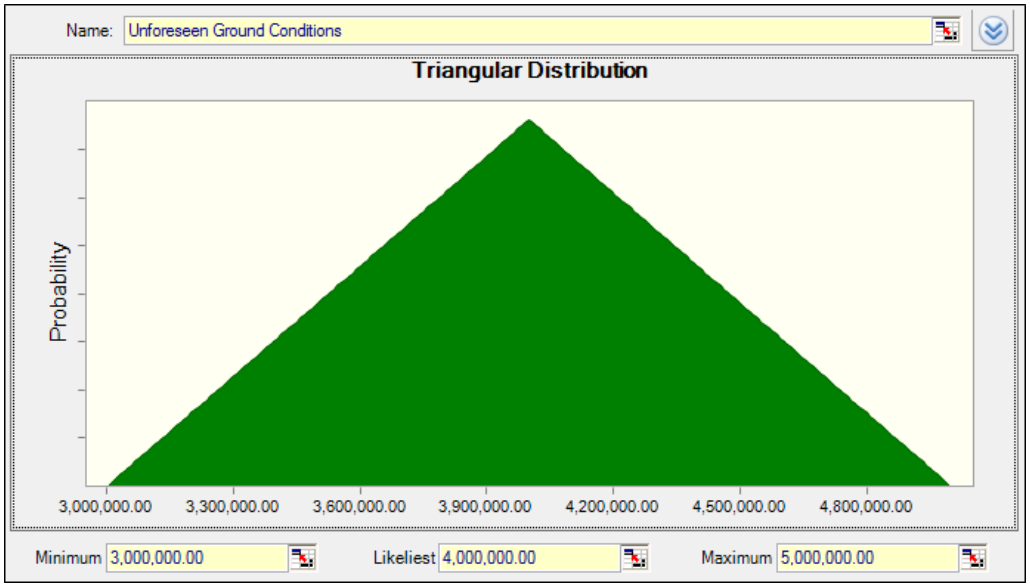

Figure 7: Example of Triangular Distribution for a Project Risk's Cost Impact

Cost Risk Analysis – Threats and Opportunities

Table 6 shows the cost threats and opportunities that were identified, quantified, and modeled for this project. The most likely cost threat amounts are shown, but a cost range was modeled for each risk.

Threat	Probability	Likely Impact
Temporary Structure to maintain traffic throughout the project	0.8	$ 8,000,000
Geotechnical construction staging	0.2	$ 7,200,000
Additional Landscaping Costs due to local public agency interest and enhanced aestetics to bridges (except blue ridge parkway)	0.7	$ 5,000,000
Aggregate Minor Risks	1	$ 6,000,000
Unexpected increase in construction claims	0.8	$ 15,000,000
Opportunity	**Probability**	**Likely Impact**
Access to median throughout project	0.5	$ 10,000,000

Table 6: Cost Threats and Opportunities

Schedule Risk Analysis – Threats & Opportunities

Table 7 shows the schedule threats and opportunities that were identified, quantified, and modeled for this project. The most likely schedule delays are shown, but a range was modeled for each risk.

Item	Threat/Opportunity	Probability	Likely Impact (Months)
Permitting	Threat	0.4	6
Access to median throughout project	Opportunity	0.5	4
French Broad River Bridge Construction	Threat	0.5	6
Temporary structure to maintain US64 Interchange	Threat	0.8	12
Coordination of MOT between contractors at project limits	Threat	0.8	5

Table 7: Schedule Threats & Opportunities

Base Variability

Base variability captures the variability and uncertainty inherently associated with the cost estimating process. Based on feedback from the Project Team and SMEs, the base variability for the estimate was determined as shown in Table 8.

Segment	Function	Base Cost Variability	Duration Variability
I-4700A/B	ROW/UT/Environmental Mitigation	5%	5%
	Construction/Landscaping	10%	10%
I-4400C/BB	All	10%	10%
I-4400BA	ROW/UT/Environmental Mitigation	5%	5%
	Construction/Landscaping	15%	10%
I-4400A	ROW/UT/Environmental Mitigation	15%	15%
	Construction/Landscaping	15%	10%

Table 8: Base Variability

Market Conditions

The primary reason for modeling market conditions is to reflect the uncertainty associated with the bidding environment. These discussions consider the potential number of bidders on project contracts and the large amount of resources that will be required to deliver the project. Other factors considered were labor and material availability and the influence of other large projects scheduled to be advertised in the same timeframe.

The CER team discussed market conditions and came up with the following probabilities and impacts as shown in Table 9 below. The probability denotes the likelihood of occurrence, and the impact denotes the magnitude as a percent of planned value for better than planned (decrease from planned value) and worse than planned (increase from planned value). The Review Team saw greater variability for the unfunded I-4400A probability as noted.

Segment	Function	Impact		Likelihood Probability	
		BtP	WtP	BtP	WtP
I-4700A/B	ROW/UT/Env. Mitigation	0%	10%	0%	25%
	Construction/Landscaping	5%	5%	10%	5%
I-4400C/BB	ROW/UT/Env. Mitigation	5%	20%	10%	15%
	Construction/Landscaping	5%	5%	10%	5%
I-4400BA	ROW/UT/Env. Mitigation	0%	0%	0%	0%
	Construction/Landscaping	10%	5%	35%	15%
I-4400A	ROW/UT/Env. Mitigation	5%	20%	10%	15%
	Construction/Landscaping	10%	5%	35%	15%

*BtP = Better than Planned; WtP = Worse than Planned

Table 9: Market Conditions

Inflation

Table 10 shows the inflation rates that NCDOT provided to FHWA for use in the Monte Carlo simulation.

Function	Annual Inflation Rate
Engineering	2.5%
Utility Relocations	3%
Right-of-Way Acquisition	4%
Construction	3%

Table 10: Inflation Rates

CONCLUSION

Table 5 summarizes the 70 percent confidence YOE results for the three Monte Carlo simulations that were run for this CER, along with a comparison to the Pre-CER Estimate. It shows the CER 70 percent estimate for the total project as $761.4M (YOE) and having increased over the Pre-CER estimate by $30.9M. However, there was a 1,430-day decrease in the completion date from the Pre-CER estimate due to revisions made during the CER, primarily to advance the I-4400A contract. In addition, it shows that a one year delay could cost $23M to the total project. For the funded portion, it shows the CER 70 percent estimate as $627.1M (YOE). The forecast for the funded phase will inform the IFP since the funding decision on I-4400A may not be made until after the IFP is approved.

This estimate is a snapshot in time and it is expected that through further project development the estimate will change. The IFP should detail any changes in the project estimate. It is recommended that the results be used in any project information conveyed to the public.

APPENDICES

A – Cost Estimate Review Closing Presentation

B – Pre-CER Cost Estimate and Schedule

C – Cost Estimate Review Agenda

D – Cost Estimate Review Sign-In Sheets

Appendix A – Cost Estimate Review Closing Presentation

Cost Estimate Review
FHWA Closing Presentation
June 2018

I-26 Widening South of Asheville
TIP # I-4400/4700

Note: During the CER, NCDOT revised dates for some of the project phases/segments based on updated information which expects an earlier overall project completion. At the close-out presentation on June 7, 2018, NCDOT and the division office clarified that a decision to fund the I-4400A phase would not be made until late in 2018 and confirmed it was reasonable to assume the new completion dates for modeling. Therefore, the original close-out presentation has been revised to reflect the funded/unfunded situation as of the CER close-out. Specifically, additional slides have been added to show the revised ROW and let dates, the YOE estimate range and schedule for the funded portion only, as well as add clarifying notes and re-title slides previously labeled for the total project to now read 'All Phases – Funded and Unfunded'. Because the model was re-run to get the new values, they are slightly different than reported originally. These additional forecasts for the funded phase will inform the IFP since the funding decision on I-4400A may not be made until after the IFP is approved.

Cost Estimate Review
FHWA Closing Presentation
June 2018

I-26 Widening South of Asheville
TIP # I-4400/4700

https://www.ncdot.gov/projects/i26Widening/

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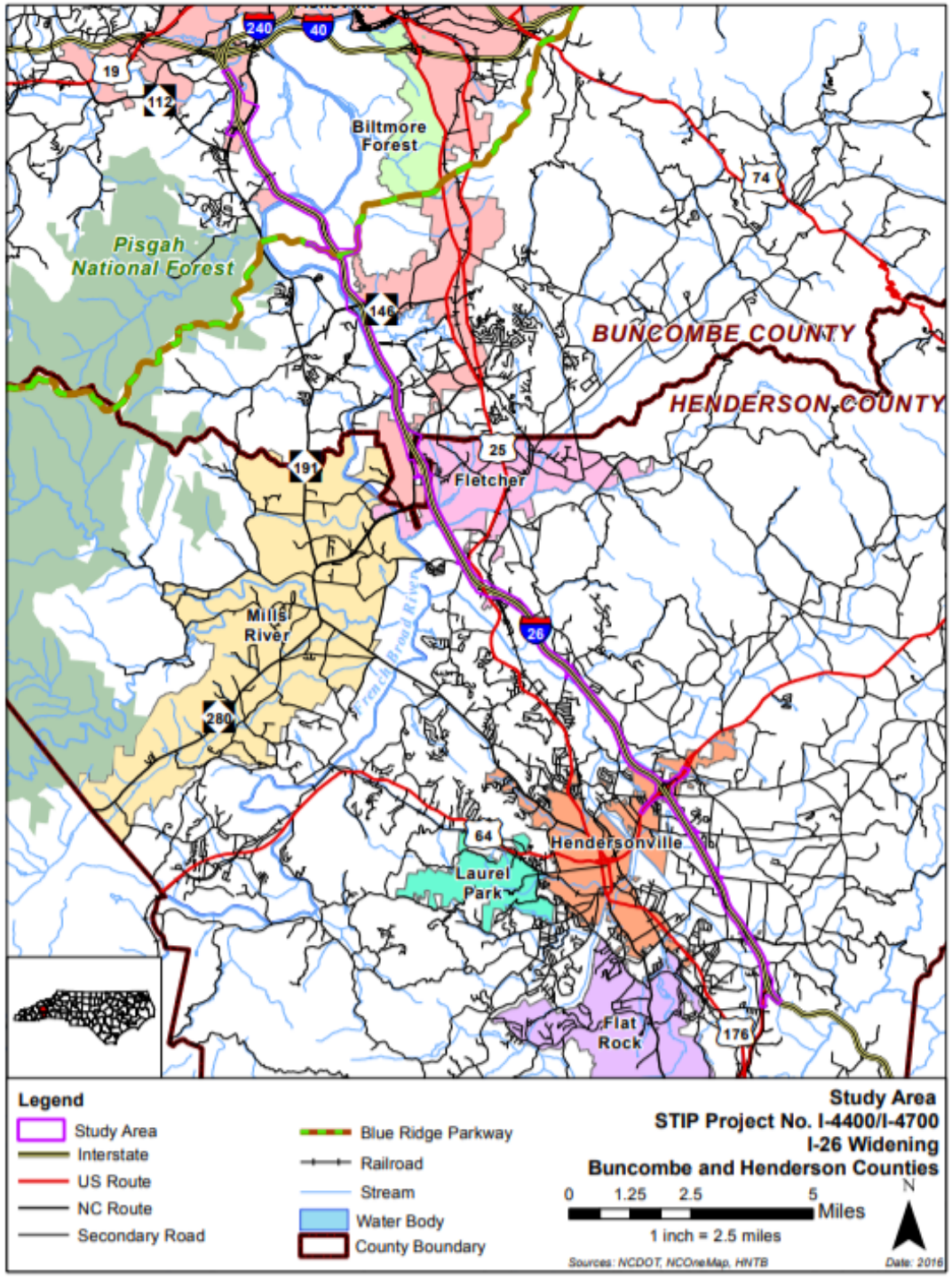
STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

Study Area



U.S. Department of Transportation
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Cost Estimate Review Objective

Conduct an unbiased risk-based review to verify the accuracy and reasonableness of the current total cost estimate and project schedule to complete the

I-26 Widening South of Asheville

and to develop a probability range for the cost estimate and schedule that represents the project's current stage of design.

I-26 Widening South of Asheville
TIP # I-4400/4700
Review Baseline for Total Project Cost
All Phases Funded & Unfunded

Current Year $

Total = $647.6 million

(Includes about $84.6M in Contingencies)

With Inflation

Total = $730.5 million

Start Construction 6/19/2019

Completion Date = 3/30/32

Cost Estimate Review Observations

- The NCDOT and consultant Team was comprised of appropriate subject matter experts (SMEs)
- State and consultant demonstrated good coordination regarding the estimate
- The SMEs understood the project elements well and were very engaged during the CER
- During the review, the project's estimate of cost and schedule was updated to current data

Cost Estimate Review Observations (cont'd)

- The Team utilized prior CER experience to enhance the review.
- Project team is working to mitigate potential issues and risks.

Cost Estimate Review
Estimate Adjustments

Pre-CER Estimate incl contingency and priors		$ 647,645,596
Risk	**Type**	**Adjustment**
Causeway elevation at French Broad River	Schedule	2 Months
Accelerated Construction for 4400 A	Schedule	-42 Months
Blue Ridge Parkway Constructability Issues	Cost	$ 2,000,000
Updated pavement design (Thicker concrete paveme	Cost	$ 14,069,213
Expected increase in slope failures due to steeper slo	Cost	$ 2,702,339
Retaining walls related to geotect delays	Cost	$ 1,168,645
Added Rest area	Cost	$ 17,839,000
Temporary pavement for maintenance of traffic	Cost	$ 22,126,834
Phased temporary drainage installation cost	Cost	$ 1,816,750
Reduced Utility Transmission costs	Cost	$ (5,000,000)
Thicker subgrade stabilization	Cost	$ 8,402,088
Percentage Based Adjustments	Cost	$ 20,180,463
Total Net Adjustments		$ 85,305,332
Post Review Estimate (Current Year)		$ 732,950,928

Summary of Adjusted Phase Schedules

Phase/Segment	Approx. % design	ROW	Letting
I-4400 A	15	July 2022	July 2024
I-4400 BA	15	June 2019	January 2020
I-4400 BB	15	December 2018	June 2019
I-4400 C	15	June 2018	June 2019
I-4700 A	70	June 2018	June 2019
I-4700 B	70	June 2018	June 2019

All projects will be design-bid-build. I-4400 BB & C will be contracted together, as will I-4700 A & B. I-4400 A & B will be contracted separately.

Major Project Cost Risks (Threats)

Threat	Probability	Likely Impact
Temporary Structure to maintain traffic throughout the project	0.8	$ 8,000,000
Geotechnical construction staging	0.2	$ 7,200,000
Additional Landscaping Costs due to local public agency interest and enhanced aestetics to bridges (except blue ridge parkway)	0.7	$ 5,000,000
Aggregate Minor Risks	1	$ 6,000,000
Unexpected increase in construction claims	0.8	$ 15,000,000

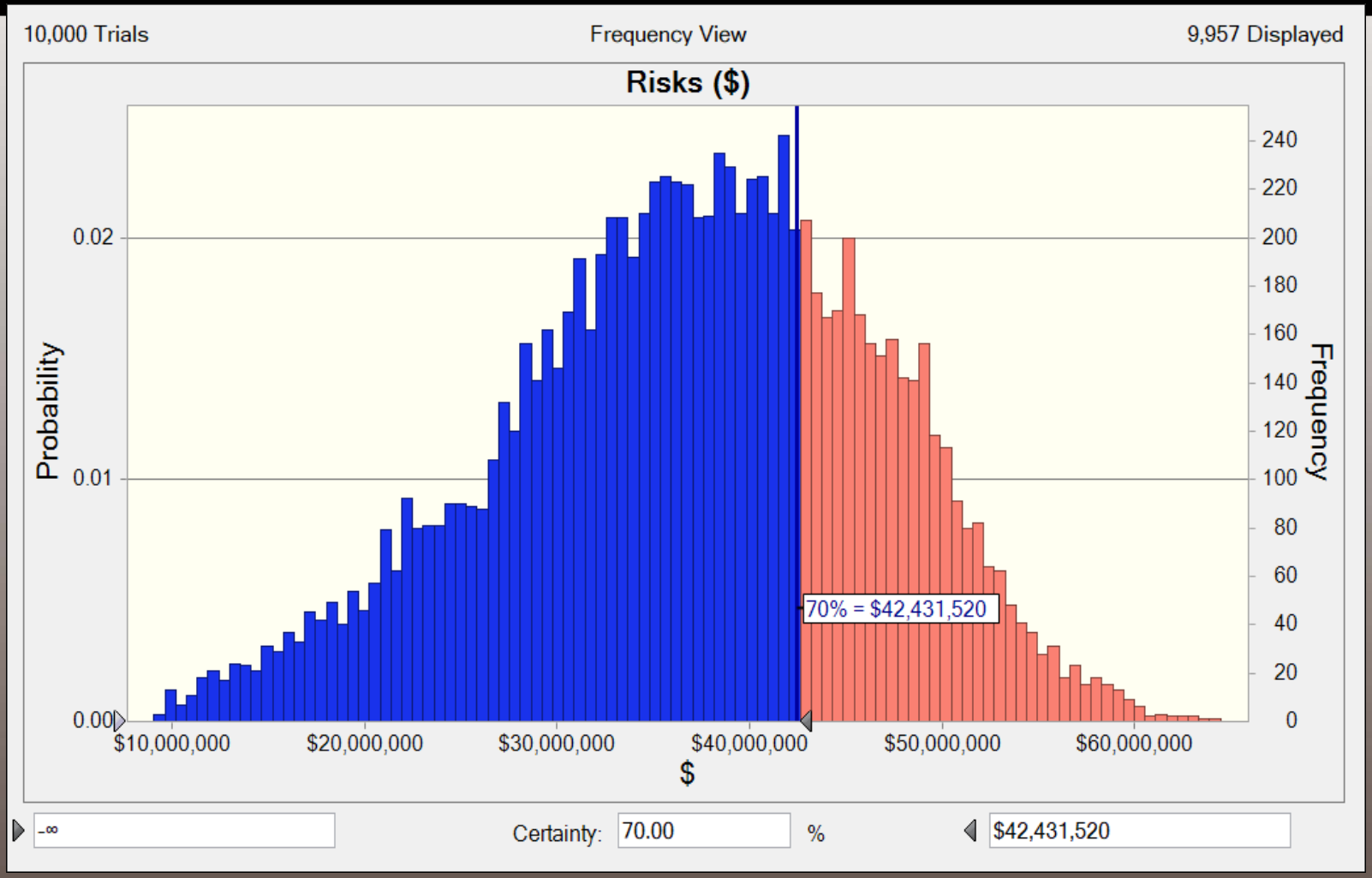
Major Project Cost Risks (Opportunities)

Opportunity	Probability	Likely Impact
Access to median throughout project	0.5	$ 10,000,000

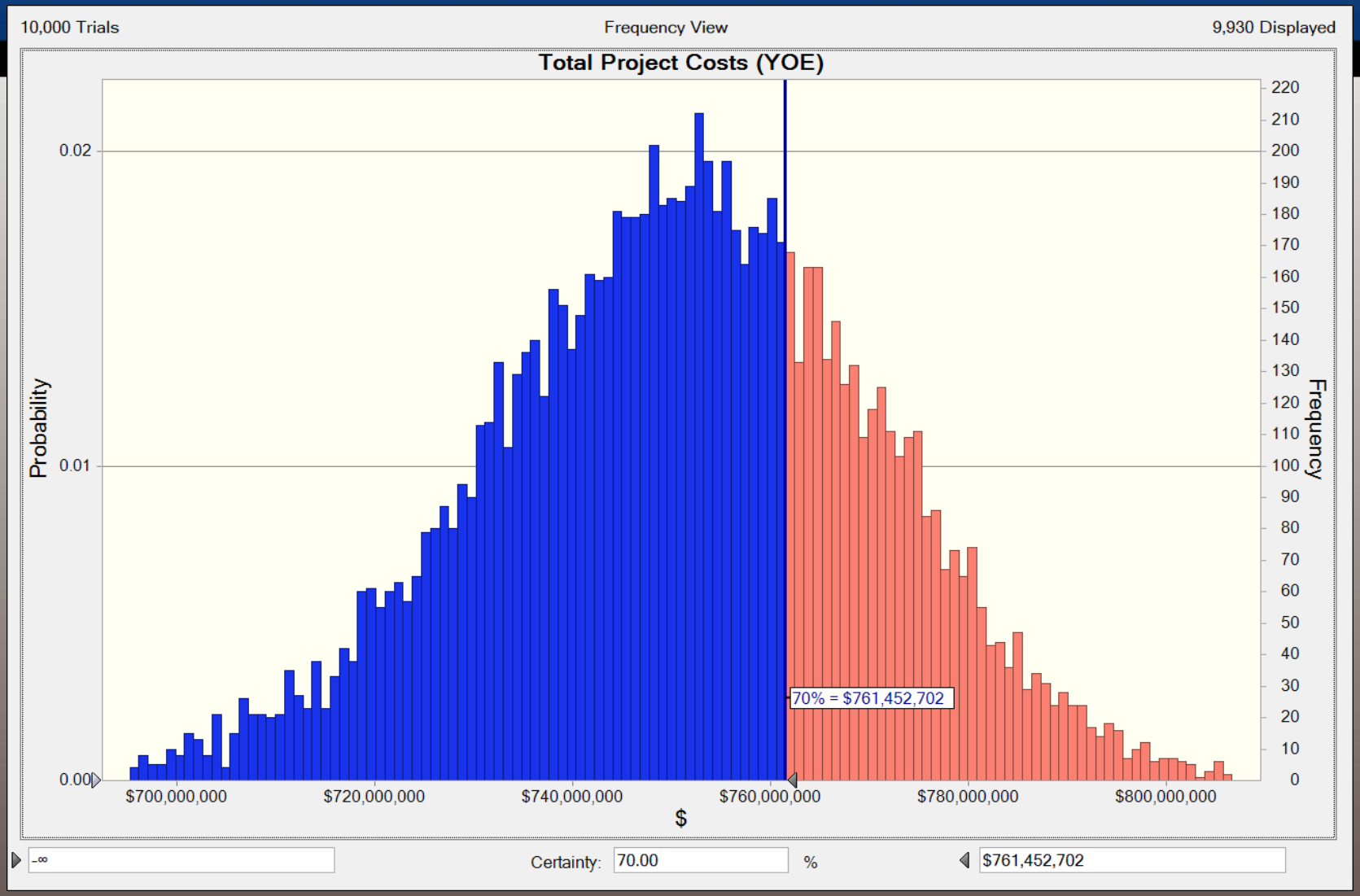
Major Project Schedule Risks (Threats & Opportunities)

Item	Threat/Opportunity	Probability	Likely Impact (Months)
Permitting	Threat	0.4	6
Access to median throughout project	Opportunity	0.5	4
French Broad River Bridge Construction	Threat	0.5	6
Temporary structure to maintain US64 Interchange	Threat	0.8	12
Coordination of MOT between contractors at project limits	Threat	0.8	5

Cost Risk Profile – All Phases



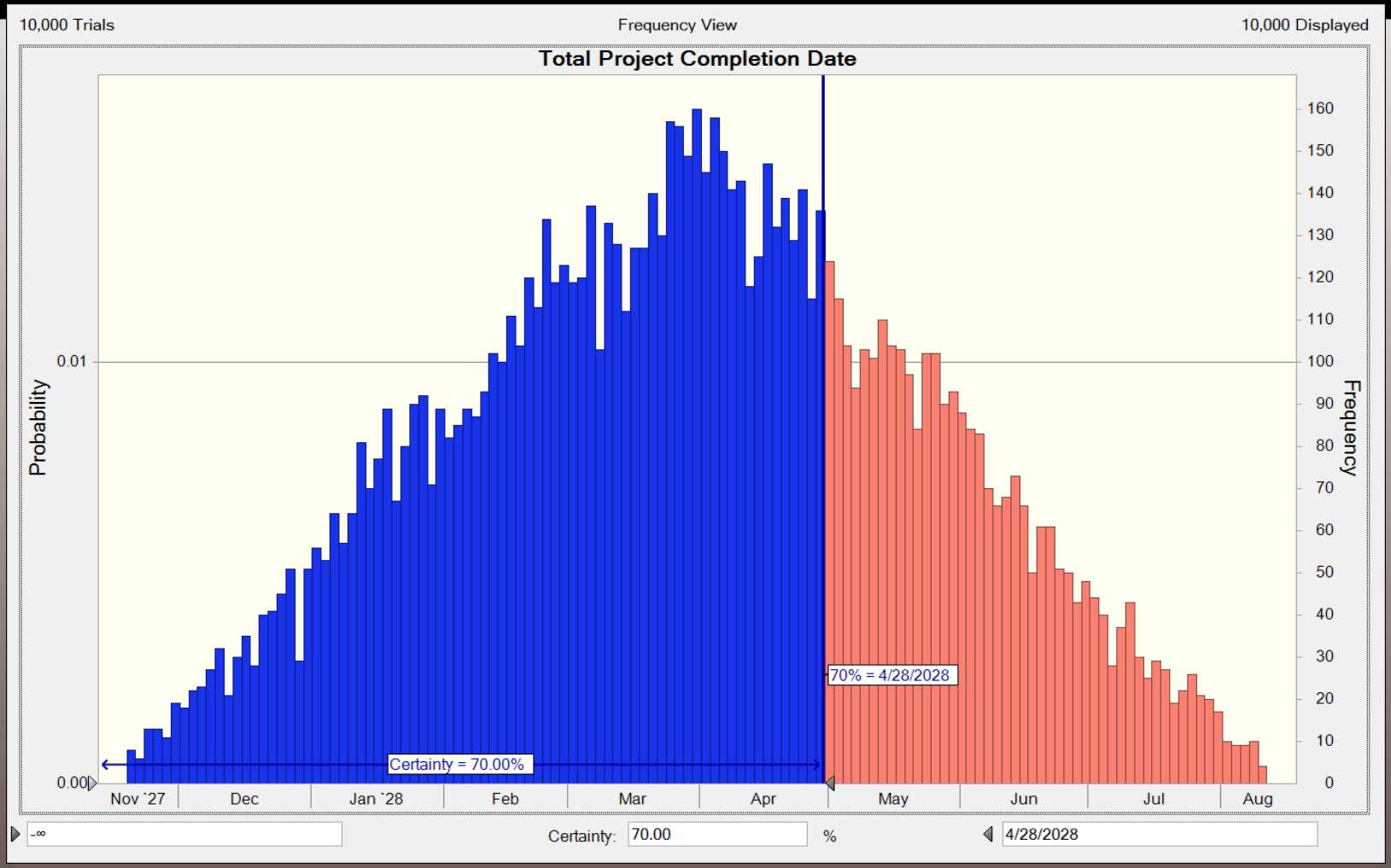
CER Outputs – Total Project Cost (YOE) All Phases - Funded & Unfunded



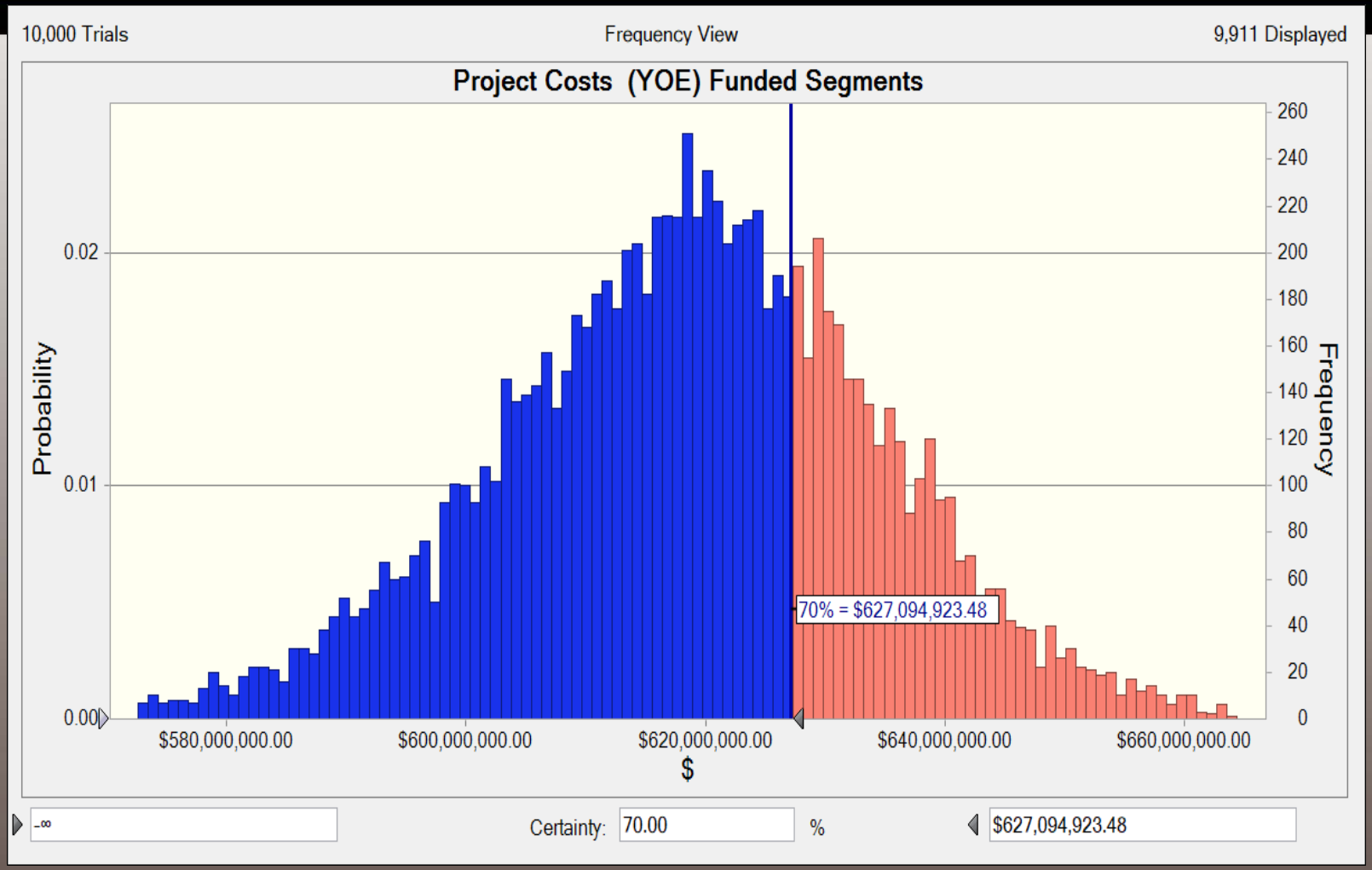
CER Outputs – Total Project Cost (YOE) All Phases - Funded & Unfunded Percentile Ranking

Percentile	Forecast values
0%	$673,306,891
10%	$725,334,457
20%	$734,515,744
30%	$741,024,049
40%	$746,491,595
50%	$751,424,768
60%	$756,089,779
70%	$761,452,702
80%	$767,611,727
90%	$775,724,820
100%	$832,572,923

CER Results – Schedule
All Phases - Funded & Unfunded



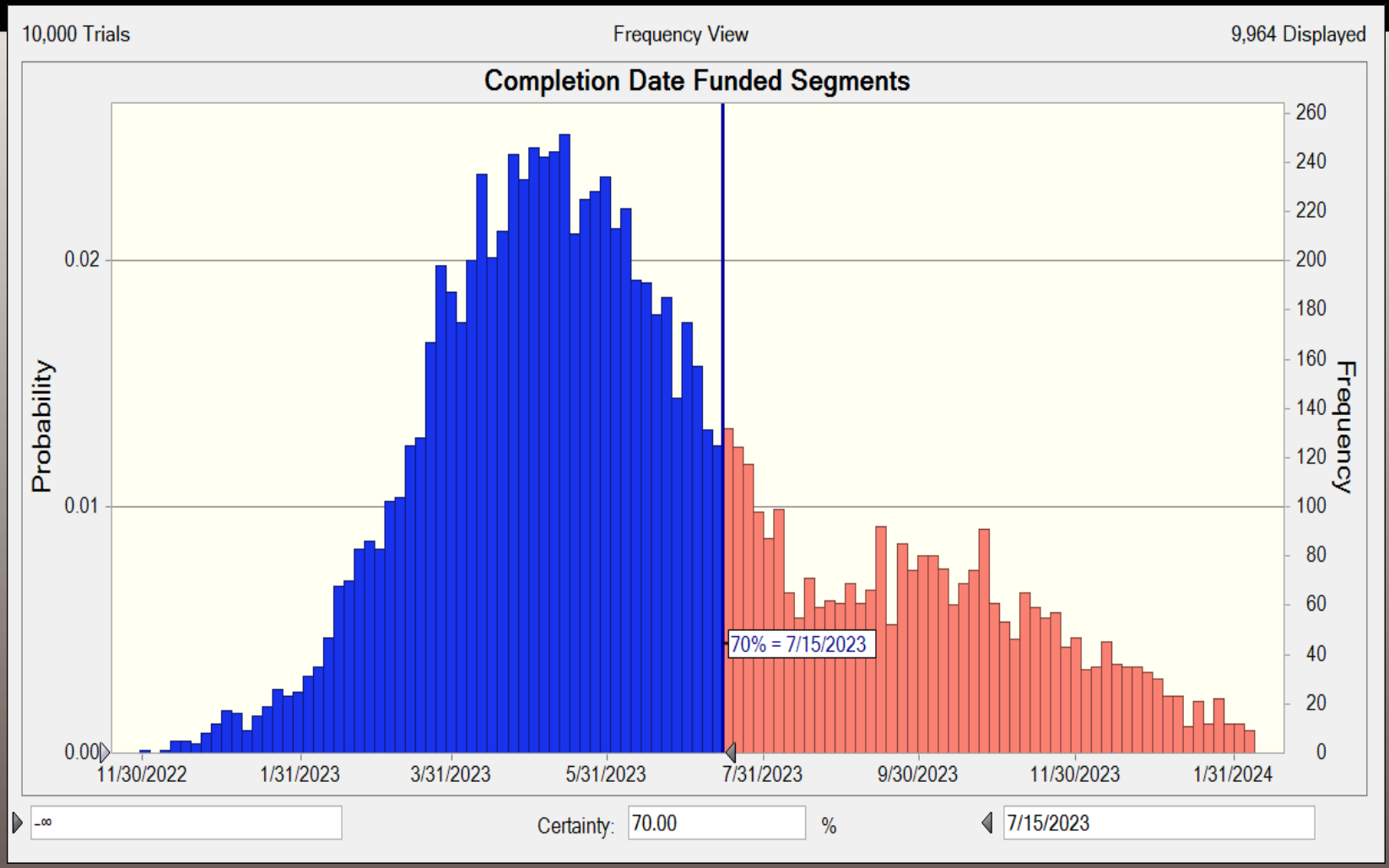
CER Outputs – Total Project Cost (YOE) Funded Phases Only (all but I-4400A)



CER Outputs – Total Project Cost (YOE) Funded Phases Only (all but I-4400A) Percentile Ranking

Percentile	Forecast Value
0%	$547,923,956
10%	$597,498,946
20%	$605,257,191
30%	$610,681,927
40%	$615,221,889
50%	$618,986,569
60%	$622,829,223
70%	$627,094,923
80%	$631,831,246
90%	$638,727,346
100%	$688,007,207

CER Results – Schedule
Funded Phases Only (all but I-4400A)



Cost Estimate Review Results Summary Comparison

#	Description	Current Year Costs	YOE	Completion Date
1	Pre-CER	$ 647,645,596	$ 730,503,608	3/30/2032
2	CER 70% Result Total Project All Phases	$ 678,407,120	$ 761,452,702	4/30/2028
	Delta from Pre-CER (#2-#1)	$ 30,761,524	$ 30,949,094	-1430
3	CER 70% Result Funded Portion	$540,303,426	$627,094,923	7/15/2023
4	CER 70% Result w/ 1 Year delay	$ 678,477,845	$ 784,851,283	4/29/2029
	Delta from CER (#4 - # 2)	$ 70,725	$ 23,398,581	12 months

Cost Estimate Review Recommendations

- Update the project estimate to reflect adjustments made during the review.
- Utilize the risk register resulting from this CER as a tool to continue managing the project's risks.
- Consider the adequacy of the risks in representing the current contingency.
- Utilize the results of the CER to inform the project's Initial Finance Plan (IFP).
- Continue strong coordination with EFL and National Park Service
- Develop an process for coordination and resolution of issues across Divisions.

CER Next Steps

- FHWA will prepare a final report documenting review findings.
  - Draft report for review within 30 days
  - Draft report will be e-mailed to Division Office
  - Division Office will review the draft and forward it to the Project Team
  - Final report issued within 30 days after receipt of comments
  - Final report forwarded to the Division Office for distribution to the Project Team
- FHWA uses the results as the official cost estimate for the project (NEPA, IFP, reporting)
- Estimate review is a snapshot of the current estimate

Cost Estimate Review
FHWA Closing Presentation
June 2018

NCDOT I-26 Widening South of Asheville

Questions?

U.S. Department of Transportation
Federal Highway Administration

Appendix B – Pre-CER Cost Estimate and Schedule

Date of Current Estimate:	4/19/2018
Current CCI:	10971.87
CCI Month:	Apr-18

Project Schedule (I-4700B)	Construction	ROW	Util	Admin	Landscaping
Estimate Date:	4/19/2018	12/5/2017	4/9/2018	4/19/2018	4/19/2018
Award Date / Start Date:	6/19/2019	7/24/2018	7/24/2018	6/19/2019	10/31/2022
Duration (mo.)	36	11	15	46	5
Completion Date:	6/19/2022	6/24/2019	10/24/2019	3/30/2023	3/30/2023
Mid-Point:	12/19/2020	12/24/2018	2/24/2019	5/19/2021	12/31/2022

Project Schedule (I-4700A/I-4400C/I-4400BB)	Construction	ROW	Util	Admin	Landscaping
Estimate Date:	4/19/2018	12/5/2017	4/9/2018	4/19/2018	4/19/2018
Award Date / Start Date:	6/19/2019	7/24/2018	7/24/2018	6/19/2019	11/1/2023
Duration (mo.)	42	10	15	58.2	5
Completion Date:	12/19/2022	5/24/2019	10/24/2019	3/30/2024	3/30/2024
Mid-Point:	3/19/2021	12/24/2018	2/24/2019	11/19/2021	1/1/2024

Project Schedule (I-4400BA)	Construction	ROW	Util	Admin	Landscaping
Estimate Date:	4/19/2018	12/5/2017	1/28/2018	4/19/2018	4/19/2018
Award Date / Start Date:	10/8/2022	10/1/2018	7/10/2022	10/8/2022	10/31/2024
Duration (mo.)	24	8	12	30.1	5
Completion Date:	10/8/2024	6/1/2019	7/10/2023	3/30/2025	3/30/2025
Mid-Point:	10/8/2023	2/1/2019	1/10/2023	1/8/2024	12/31/2024

Project Schedule (I-4400A)	Construction	ROW	Util	Admin	Landscaping
Estimate Date:	4/19/2018	12/5/2017	1/28/2018	4/19/2018	4/19/2018
Award Date / Start Date:	2/5/2028	8/9/2027	8/9/2027	2/5/2028	11/1/2031
Duration (mo.)	36	12	15	50.5	5
Completion Date:	2/5/2031	8/9/2028	11/9/2028	3/30/2032	3/30/2032
Mid-Point:	8/5/2029	2/9/2028	3/9/2028	3/5/2030	1/1/2032

Inflation Rates	Base Case
Construction:	3.0%
Landscaping:	3.0%
ROW:	4.0%
Utilities:	3.0%
Administrative:	2.5%
Environmental:	2.0%

Existing Data:	Base Case	
Non-riparian wetland impacts, AC:	$ 51,782	2017 DMS fee in lieu
Riparian wetland impacts, AC:	$ 71,772	

	I-4400 (34232)	I-4700A (36030)	I-4700B (36030)	
Prior Expenditures for P/E (thru 3/31/18):	$ 8,304,395	$ 1,736,590	$ 2,299,023	$ 12,340,008

Contingency and Allowance Assumptions:	Base Case		
Construction Contingency (Functional Design):	15.0%		
Construction Contingency (ROW Plans):	15.0%		
Settlement above appraisal:	70.0%	covers settlements over appraised values and condemnations	
Condemnation rate:	50.0%	covers settlements over appraised values and condemnations	
Acquisition Cost w/o relocation/parcel:	$ 10,500		
Acquisition Cost w/ relocation/parcel:	$ 17,000		
Residential Relocation Cost, Per Parcel:	$ 50,000		
Business Relocation Cost, Per Parcel:	$ 75,000		
Sign Relocation Cost:	$ 30,000		
Design-Build Risk:	0.0%		
Design-Build Engineering:	0.0%		
Landscaping Allowance:	1.00%		
Planning and Engineering (NEPA)	$ 430,000	/per month until letting (9 month average)	15.0 months (April 18 - June 19)
Agency Costs during Construction	2.0%		
Public Education and Outreach	$ 50,000	Estimated Communications/Public Info during construction	
CEI and Materials Testing (6%)	6.0%		

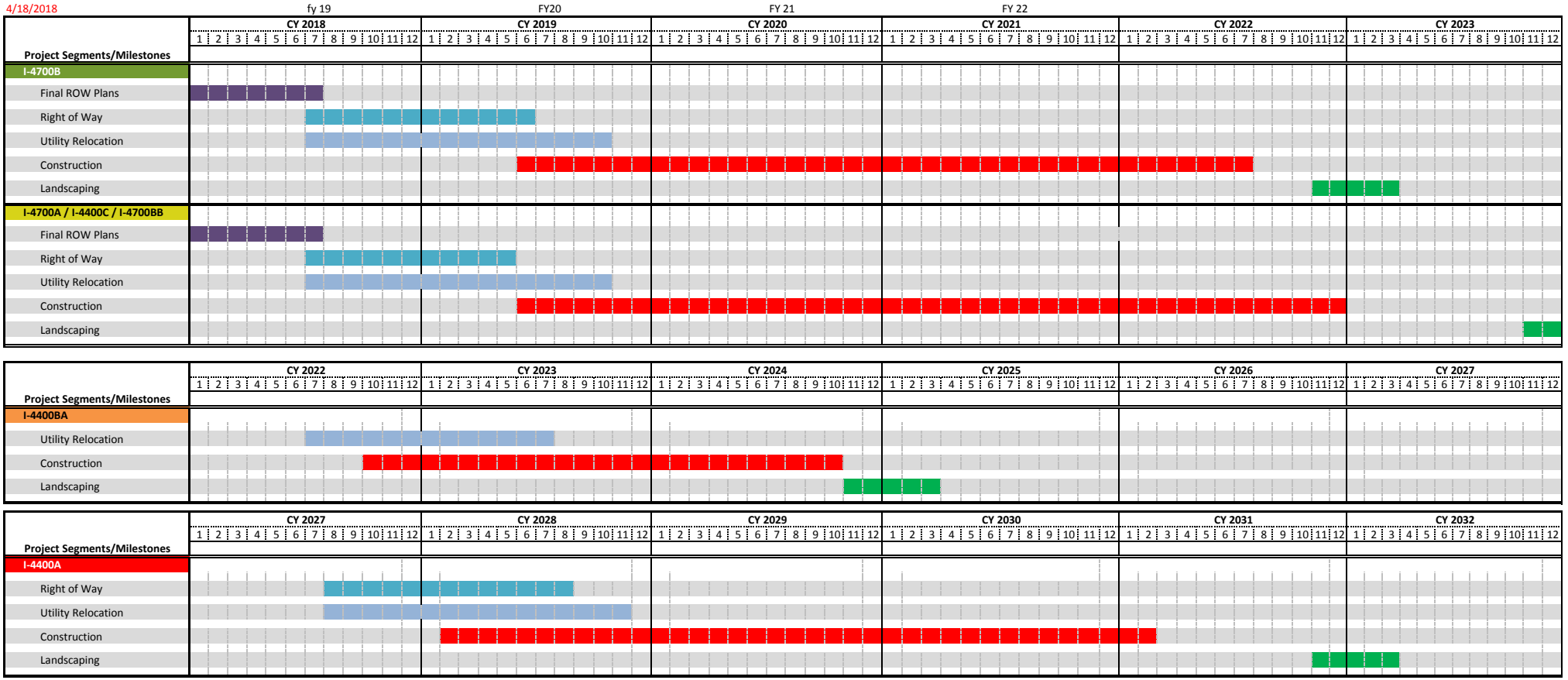
		I-4400A	I-4400B	I-4400C	I-4700
Stipends	$ -	$ -	$ -	$ -	$ -
Engineering Reserve Fund	2.0%	to cover unknowns during design and construction (i.e., delays, geotech risk)			
Agency Reserve Fund	2.0%	to cover unexpected costs for ROW, utilities, administration			
Scope Changes / Change Orders	5.0%	to cover owner directed change orders			

		Current Year Dollars				YOE Dollars
STIP Project	Cost Stage	Cost Estimate incl. Contingency	Contingency Estimate	Start	End	Cost Estimate incl. Contingency
I-4700B	Construction	$ 111,947,000	$ 14,602,000	6/19/2019	6/19/2022	$ 121,280,000
	Landscaping	$ 1,120,000	$ -	10/31/2022	3/30/2023	$ 1,290,000
	ROW	$ 38,000	$ 5,000	7/24/2018	6/24/2019	$ 39,700
	Utilities	$ 66,000		7/24/2018	10/24/2019	$ 68,000
	Env. Mitigation	$ 3,555,105		6/19/2019	6/19/2019	$ 3,640,000
	Admin.	$ 24,162,500	$ 4,526,200	6/19/2019	3/30/2023	$ 25,710,000
	Priors	$ 2,299,023		3/28/2003	3/31/2018	$ 2,299,023
	TOTALS	**$ 143,187,628**	**$ 19,133,200**			**$ 154,326,723**
I-4700A	Construction	$ 82,468,301	$ 10,757,000	6/19/2019	12/19/2022	$ 90,010,000
	Landscaping	$ 830,000	$ -	11/1/2023	3/30/2024	$ 990,000
	ROW	$ 90,000	$ 20,000	7/24/2018	5/24/2019	$ 93,900
	Utilities	$ 5,769,500		7/24/2018	10/24/2019	$ 5,924,000
	Env. Mitigation	$ 818,991		6/19/2019	6/19/2019	$ 839,000
	Admin.	$ 19,747,500	$ 3,564,600	6/19/2019	3/30/2024	$ 21,140,000
	Priors	$ 1,736,590		3/28/2003	3/31/2018	$ 1,736,590
	TOTALS	**$ 111,460,882**	**$ 14,341,600**			**$ 120,733,490**
I-4400C	Construction	$ 96,031,100	$ 12,526,000	6/19/2019	10/8/2023	$ 104,810,000
	Landscaping	$ 970,000		11/1/2023	3/30/2024	$ 1,160,000
	ROW	$ 2,532,000	$ 588,000	7/24/2018	5/24/2019	$ 2,650,000
	Utilities	$ 564,000		7/24/2018	10/24/2019	$ 580,000
	Env. Mitigation	$ 2,512,886		6/19/2019	6/19/2019	$ 2,580,000
	Admin.	$ 23,007,500	$ 3,953,400	6/19/2019	3/30/2024	$ 24,570,000
	Priors	$ 2,740,450		6/30/2002	3/31/2018	$ 2,740,450
	TOTALS	**$ 128,357,936**	**$ 17,067,400**			**$ 139,090,450**
I-4400BB	Construction	$ 97,004,600	$ 12,653,000	6/19/2019	10/8/2023	$ 105,870,000
	Landscaping	$ 980,000		11/1/2023	3/30/2024	$ 1,170,000
	ROW	$ 3,050,000	$ 700,000	7/24/2018	5/24/2019	$ 3,181,000
	Utilities	$ 1,788,000		7/24/2018	10/24/2019	$ 1,836,000
	Env. Mitigation	$ 1,895,837		6/19/2019	6/19/2019	$ 1,950,000
	Admin.	$ 23,319,000	$ 4,052,000	6/19/2019	3/30/2024	$ 24,910,000
	Priors	$ 1,411,747		6/30/2002	3/31/2018	$ 1,411,747
	TOTALS	**$ 129,449,184**	**$ 17,405,000**			**$ 140,328,747**
I-4400BA	Construction	$ 21,024,900	$ 2,743,000	10/8/2022	10/8/2024	$ 24,780,000
	Landscaping	$ 220,000		10/31/2024	3/30/2025	$ 270,000
	ROW	$ -	$ -	10/1/2018	6/1/2019	$ -
	Utilities	$ 221,000		7/10/2022	7/10/2023	$ 257,000
	Env. Mitigation	$ -		10/8/2022	10/8/2022	$ -
	Admin.	$ 10,073,000	$ 858,800	10/8/2022	3/30/2025	$ 10,640,000
	Priors	$ 1,411,747		6/30/2002	3/31/2018	$ 1,411,747
	TOTALS	**$ 32,950,647**	**$ 3,601,800**			**$ 37,358,747**
I-4400A	Construction	$ 76,206,200	$ 9,940,000	2/5/2028	2/5/2031	$ 106,940,000
	Landscaping	$ 770,000		11/1/2031	3/30/2032	$ 1,170,000
	ROW	$ 236,000	$ 59,000	8/9/2027	8/9/2028	$ 360,000
	Utilities	$ 195,000		8/9/2027	11/9/2028	$ 265,000
	Env. Mitigation	$ 2,575,468		2/5/2028	2/5/2028	$ 3,140,000
	Admin.	$ 19,516,200	$ 3,091,700	2/5/2028	3/30/2032	$ 24,050,000

	Priors	$	2,740,450			6/30/2002	3/31/2018	$	2,740,450
	TOTALS	**$**	**102,239,318**	**$**	**13,090,700**			**$**	**138,665,450**
I-4400 / I-4700 COMBINED	Construction	$	484,682,101	$	63,221,000	6/19/2019	2/5/2031	$	553,690,000
	Landscaping	$	4,890,000	$	-	10/31/2022	3/30/2032	$	6,050,000
	ROW	$	5,946,000	$	1,372,000	7/24/2018	8/9/2028	$	6,324,600
	Utilities	$	8,603,500	$	-	7/24/2018	11/9/2028	$	8,930,000
	Env. Mitigation	$	11,358,287	$	-	6/19/2019	2/5/2028	$	12,149,000
	Admin.	$	119,825,700	$	20,046,700	6/19/2019	3/30/2032	$	131,020,000
	Priors	$	12,340,008	$	-	6/30/2002	3/31/2018	$	12,340,008
	TOTALS	**$**	**647,645,596**	**$**	**84,639,700**			**$**	**730,503,608**

IMPLEMENTATION SCHEDULE
I-4400 / I-4700 I-26 WIDENING

4/18/2018



Appendix C – Cost Estimate Review Agenda

FHWA / NCDOT
I-4400 / I-4700 I-26 Widening Project
Cost Estimate Review
Agenda

Dates: June 5, 2018 – June 7, 2018

Location: NCDOT Century Center – Building B
PDEA Large Conference Room
1020 Birch Ridge Road
Raleigh, NC 27610

CER Facilitators: Michael Smith, FHWA Resource Center
David Unkefer, FHWA Resource Center
Andrew Callihan, FHWA Resource Center
Jim Martin, FHWA Major Projects Engineer, NC Division Office

Core NCDOT Team:
Ted Adams, Division 14 Construction Engr.
Wanda Austin, Division 14 Proj. Dev. Engr.
Steve Cannon, Div. 13 Project Dev. Engr.
Phil Culpepper, Estimating Unit
Forrest Dungan, Estimating Unit
Randy McKinney, Division 13 Const. Engr.
Karen Lovering, Estimating Unit
Brendan Merithew, Div. 13 Proj. Team Lead
Beverly Robinson, Project Delivery Team
Derrick Weaver, Project Delivery Team
Bill Zerman, Project Delivery Team

Core Consultant Team:
Kat Bukowy, HNTB
Jennifer Harris, HNTB
Jeff Hess, HNTB
Donna Keener, HNTB
Joe Olson, HNTB

TUESDAY 06/05/18	TOPIC	INVITEES
10:00 a.m.	CER Introduction by FHWA	Mike Tessitore, FHWA Eastern Federal Lands Chris Werner, Technical Services Director Virginia Mabry, Project Delivery Manager Jay Swain, Division Engineer, Div. 13 Brian Burch, Division Engineer, Div. 14 Marissa Cox, Biological Surveys Harry Lucas, Estimating Unit John Jamison, Project Development Joanna Rocco, AECOM (observing) Celia Miars, AECOM (observing)
10:45 a.m.	Project Overview by Project Personnel	
11:30	Overview State Estimation Process	Harry Lucas, Estimating Unit
12:00 noon	Lunch	
1:00 p.m.	Base Variability & Market Conditions	Core Project Team
2:00 p.m.	Soft Costs (administrative, inflation, allowances)	
2:30 p.m.	Contingency/Risk Register Items	

3:30 p.m.	Structures, Retaining Walls, Railroad Coordination, and Sound Barriers	Mike Tessitore, FHWA Eastern Federal Lands George Choubah, FHWA Eastern Federal Lands Sheila Foronda, FHWA Wendy McAbee, FHWA Kevin Fischer, Asst. State Structures Engineer David Stutts, Structures Project Engineer Cameron Cochran, Regional Bridge Const. Engr. Missy Pair, Noise & Air Harry Lucas, Estimating Unit David Hawkins, HNTB Structures Tracy Roberts, HNTB Noise Corey Vernier, HNTB Rail
5:00 p.m.	Adjourn	
WEDNESDAY 06/06/18	**TOPIC**	**INVITEES**
8:00 a.m.	Recap of Day 1	Core Project Team
8:30 a.m.	Earthwork, Drainage, Pavement, Roadway, Geotechnical	Kevin Moore, Roadway Jody Kuhne, Regional Geological Engineer Matt Foster, HNTB Hydraulics Mark Whitmore, HNTB Roadway
9:30 a.m.	Roadside Environmental (Erosion Control & Landscaping)	Mark Staley, Roadside Environmental Engineer Jeremy Goodwin, Erosion Control Jeff Lackey, Aesthetic Engineering Bob Kopetsky, Landscape Design James Parrish, Rest Area Section Paul Stankiewicz, Rest Area Section Matt Foster, HNTB Erosion Control
10:00 a.m.	Traffic Control, Signing, Lighting	Don Parker, Work Zone Traffic Control Roger Garrett, Work Zone Traffic Control Kelvin Jordan, Signing Jose Martinez, Signing Paul Chan, Lighting Greg Hall, Lighting Rhonda Early, HNTB Traffic Control Andy Klinksiek, HNTB Signing
10:30 a.m.	Traffic Signals and ITS	Tim Williams, Signal Design Nicholas Zinser, Signal Design Paul Marak, ITS Design Gregg Green, ITS Design Bucky Galloway, Western Region Field Ops Anna Henderson, Division 13 Steve Buchanan, Division 14 Natasha Simmons, HNTB Signals / ITS
11:00 a.m.	Environmental/ Permitting/Mitigation	Marissa Cox, Biological Surveys Carla Dagnino, Env. Coordination & Permitting Bill Barrett, Env. Coordination & Permitting Roger Bryan, Div. 13 Environmental Supervisor David McHenry, Div. 14 Environmental Supervisor
12:00 p.m.	Lunch	

1:00 p.m.	Utilities (wet and dry)	Greg Sealy, Sr. Utility Coordinator Wesley Jamison, Division 14 Project Manager Robert Golding, Division 14 Utility Engineer Joshua Barbour, KCI John Faison, KCI Reece Schuler, Vaughn & Melton
1:30 p.m.	Right of Way	Norman Medford, Area ROW Appraiser Sean Ward, ROW Appraiser
2:00 p.m.	Revisit estimate items, i.e. soft costs – as necessary	Core Project Team
3:30 p.m.	Review and finalize risk register details, including descriptions and aggregate minor risks	
5:00 p.m.	Adjourn	
THURSDAY 06/07/18	**TOPIC**	**INVITEES**
8:00 a.m.	Findings and Report Preparation	None (FHWA)
8:30 a.m.	Presentation Dry Run	Core Project Team
9:30 a.m.	Closeout Presentation	Chris Werner, Technical Services Director Virginia Mabry, Project Delivery Manager Jay Swain, Division Engineer, Div. 13 Brian Burch, Division Engineer, Div. 14
10:30 a.m.	Adjourn	

Appendix D – Cost Estimate Review Sign-In Sheets

FHWA / NCDOT
STIP Nos. I-4400 & I-4700 (I-26 Widening)
Cost Estimate Review
Sign-In Sheet

	TUESDAY, JUNE 5, 2018			TIME / TOPIC		
				10:00 a.m.	10:45 a.m.	11:15 a.m.
	Name	Representing	Email Address / Phone Number	CER Introduction by FHWA	Project Overview by Project Personnel	Overview State Estimation Process
FHWA	Andrew Callihan	FHWA	andrew.callihan@dot.gov	✓	✓	✓
FHWA	Jim Martin	FHWA	James.Martin@dot.gov	✓	✓	✓
FHWA	Michael Smith	FHWA		✓	✓	✓
FHWA	David Unkefer			✓	✓	✓
CORE PROJECT TEAM	Ted Adams					
CORE PROJECT TEAM	Wanda Austin	NCDOT	whaustin@ncdot.gov	✓	✓	✓
CORE PROJECT TEAM	Kat Bukowy	HNTB	kbukowy@~~ncdot~~hntb.com	✓	✓	✓
CORE PROJECT TEAM	Steve Cannon					
CORE PROJECT TEAM	Philip Culpepper	NCDOT	pculpepper@ncdot.gov	✓	✓	✓
CORE PROJECT TEAM	Forrest Dungan					
CORE PROJECT TEAM	Jennifer Harris	HNTB	jhharris@hntb.com	✓	✓	✓
CORE PROJECT TEAM	Jeff Hess	HNTB	jhess@hntb.com	✓	✓	✓
CORE PROJECT TEAM	Donna Keener	HNTB	dckeener@hntb.com	✓	✓	✓
CORE PROJECT TEAM	Karen Lovering					
CORE PROJECT TEAM	Randy McKinney					
CORE PROJECT TEAM	Brendan Merithew					
CORE PROJECT TEAM	Joe Olson	HNTB	jsolson@hntb.com	✓	✓	✓
CORE PROJECT TEAM	Beverly Robinxon	NCDOT	brobinson@ncdot.gov 9197076041	✓	✓	✓
CORE PROJECT TEAM	Derrick Weaver	NCDOT	DWEAVER@NCDOT.GOV	✓	✓	✓
CORE PROJECT TEAM	Bill Zerman	NCDOT	bzerman@ncdot.com	✓	✓	✓

INVITEES / SUBJECT MATTER EXPERTS

TUESDAY, JUNE 5, 2018			10:00 a.m.	10:45 a.m.	11:15 a.m.
Name	**Representing**	**Email Address / Phone Number**	CER Introduction by FHWA	Project Overview by Project Personnel	Overview State Estimation Process
Brian Burch	NCDOT-DIV	PHONE	✓		
Marissa Cox	NCDOT-EAU-BSG	MRCOX@ncdot.gov	✓	✓	✓
John Jamison	NCDOT-EPM	707-6140	✓	✓	✓
Harry Lucas					
Virginia Mabry					
Celia Miars	AECOM	celia.fonshee@aecom.com	✓	✓	✓
Joanna Rocco	AECOM	joanna.rocco@aecom.com	✓	✓	✓
Jay Swain					
Michael Tessitore	FHWA-EFL	PHONE michael.tessitore@dot.gov	✓	✓	
Chris Werner					

FHWA / NCDOT
STIP Nos. I-4400 & I-4700 (I-26 Widening)
Cost Estimate Review
Sign-In Sheet

	TUESDAY, JUNE 5, 2018			TIME / TOPIC			
				1:00 p.m.	2:00 p.m.	2:30 p.m.	3:30 p.m.
	Name	Representing	Email Address / Phone Number	Base Variability & Market Conditions	Soft Costs (administrative, inflation, allowances)	Contingency/Risk Register Items	Structures, Retaining Walls, Railroad Coordination, and Sound Barriers
FHWA	Andrew Callihan	FHWA		✓	✓	✓	✓
FHWA	Jim Martin	FHWA		✓	✓	✓	✓
FHWA	Michael Smith	FHWA		✓	✓	✓	✓
FHWA	David Unkefer	FHWA		✓	✓	✓	✓
CORE PROJECT TEAM	Ted Adams						
CORE PROJECT TEAM	Wanda Austin	D14		✓	✓	✓	✓
CORE PROJECT TEAM	Kat Bukowy	HNTB - env.		✓	✓	✓	✓
CORE PROJECT TEAM	Steve Cannon						
CORE PROJECT TEAM	Philip Culpepper	NCDOT - estimates		✓	✓	✓	✓
CORE PROJECT TEAM	Forrest Dungan						
CORE PROJECT TEAM	Jennifer Harris	HNTB		✓	✓	✓	✓
CORE PROJECT TEAM	Jeff Hess	HNTB - roadway		✓	✓	✓	✓
CORE PROJECT TEAM	Donna Keener	HNTB		✓	✓	✓	✓
CORE PROJECT TEAM	Karen Lovering						
CORE PROJECT TEAM	Randy McKinney	D13		✓	✓	✓	✓
CORE PROJECT TEAM	Brendan Merithew						
CORE PROJECT TEAM	Joe Olson	HNTB - roadway		✓	✓	✓	✓
CORE PROJECT TEAM	Beverly Robinxon	NCDOT		✓	✓	✓	✓
CORE PROJECT TEAM	Derrick Weaver						
CORE PROJECT TEAM	Bill Zerman	NCDOT		✓	✓	✓	✓

INVITEES / SUBJECT MATTER EXPERTS

TUESDAY, JUNE 5, 2018			1:00 p.m.	2:00 p.m.	2:30 p.m.	3:30 p.m.
Name	**Representing**	**Email Address / Phone Number**	Base Variability & Market Conditions	Soft Costs (administrative, inflation, allowances)	Contingency/Risk Register Items	Structures, Retaining Walls, Railroad Coordination, and Sound Barriers
George Choubah	FHWA - EFL	PHONE				✓
Cameron Cochran	NCDOT - regional bridge	PHONE				✓
Sheila Foronda	FHWA - EFL	PHONE				✓
Kevin Fischer	NCDOT - structures					✓
David Hawkins	HNTB - structures					✓
Harry Lucas	NCDOT - estimates					✓
Wendy McAbee						
Missy Pair	NCDOT - Noise & Air					✓
Tracy Roberts	HNTB - NCDOT - Noise & Air					✓
David Stutts						
Mike Tessitore	FHWA - EFL	PHONE				✓
Corey Vernier	HNTB - rail					✓

FHWA / NCDOT
STIP Nos. I-4400 & I-4700 (I-26 Widening)
Cost Estimate Review
Sign-In Sheet

	WEDNESDAY, June 6, 2018			TIME / TOPIC									
				8:00 a.m.	8:30 a.m.	9:30 a.m.	10:00 a.m.	10:30 a.m.	11:00 a.m.	1:00 p.m.	1:30 p.m.	2:00 p.m.	3:30 p.m.
	Name	Representing	Email Address / Phone Number	Recap of Day 1	Earthwork, Drainage, Pavement, Roadway, Geotechnical	Environmental / Permitting / Mitigation	Traffic Control, Signing, Lighting	Traffic Signals and ITS	Environmental / Permitting / Mitigation	Utilities (wet and dry)	Right of Way	Revisit estimate items, i.e. soft costs as necessary	Review and finalize risk register details
FHWA	Andrew Callihan	FHWA	andrew.callihan@dot.gov	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FHWA	Jim Martin	FHWA	James.Martin@dot.gov	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FHWA	Michael Smith	FHWA											
FHWA	David Unkefer	FHWA											
CORE PROJECT TEAM	Ted Adams												
CORE PROJECT TEAM	Wanda Austin	NCDOT	whaustin@ncdot.gov	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CORE PROJECT TEAM	Kat Bukowy	HNTB											
CORE PROJECT TEAM	Steve Cannon												
CORE PROJECT TEAM	Philip Culpepper						✓	✓	✓				
CORE PROJECT TEAM	Forrest Dungan												
CORE PROJECT TEAM	Jennifer Harris	HNTB											
CORE PROJECT TEAM	Jeff Hess	HNTB	jhess@hntb.com										
CORE PROJECT TEAM	Donna Keener	HNTB	dkeener@hntb.com 707-0637	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CORE PROJECT TEAM	Karen Lovering	NCDOT Fest.Mgmt	klovering@ncdot.gov	✓	✓	✓	✓		✓		✓	✓	✓
CORE PROJECT TEAM	Randy McKinney	NCDOT	rmckinney@NCDOT.GOV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CORE PROJECT TEAM	Brendan Merithew												
CORE PROJECT TEAM	Joe Olson	HNTB	jsolson@hntb.com	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CORE PROJECT TEAM	Beverly Robinxon	NCDOT	PHONE	✓	✓	✓							
CORE PROJECT TEAM	Derrick Weaver												
CORE PROJECT TEAM	Bill Zerman	NCDOT PMN	bzerman@NCDOT.GOV	✓	✓								

INVITEES / SUBJECT MATTER EXPERTS

WEDNESDAY, June 6, 2018			8:00 a.m.	8:30 a.m.	9:30 a.m.	10:00 a.m.	10:30 a.m.	11:00 a.m.	1:00 p.m.	1:30 p.m.	2:00 p.m.	3:30 p.m.
Name	**Representing**	**Email Address / Phone Number**	**Recap of Day 1**	**Earthwork, Drainage, Pavement, Roadway, Geotechnical**	**Environmental / Permitting / Mitigation** (Roadside)	**Traffic Control, Signing, Lighting**	**Traffic Signals and ITS**	**Environmental / Permitting / Mitigation**	**Utilities (wet and dry)**	**Right of Way**	**Revisit estimate items, i.e. soft costs as necessary**	**Review and finalize risk register details**
Joshua Barbour	KCI UTILITIES	Joshua.Barbour@KCI.com							✓			
Bill Barrett												
Roger Bryan	NCDOT - Div 13	rdbryan@ncdot.gov			✓							
Steve Buchanan												
Paul Chan												
Marissa Cox	NCDOT - EAU - BSG	mrcox@ncdot.gov			✓			✓				
Carla Dagnino	NCDOT - EAU - ECAP	cdagnino@ncdot.gov			✓			✓				
Rhonda Early	HNTB - WZTC	919 424 0426 REarly@HNTB.com				✓						
John Faison	KCI Utilities	919-630-2569 John.Faison@KCI.com							✓			
Matt Foster	HNTB	mfoster@hntb.com 919-928-6229		✓	✓							
Bucky Galloway												
Roger Garrett (by phone)	NCDOT - WZTC					✓						
Robert Golding	UTILITIES								✓ phone			
Jeremy Goodwin	NCDOT - Roadside Env	jagoodwin@ncdot.gov 919-707-2442			✓							
Gregg Green	NCDOT - ITS	ggreen@ncdot.gov					✓					
Greg Hall												
Anna Henderson												
Wesley Jamison												
Kelvin Jordan	NCDOT - Signing & Delineation	kjordan@NCDOT.GOV 919-814-4945				✓						
Andy Klinksiek	HNTB	aklinksiek@hntb.com 919 424 0477				✓						
Bob Kopetsky	~~AESTH & LANDSCAPE~~ REU ENG	bkopetsky@ncdot.gov			✓			✓				
~~Jody Kuhne~~ JEFF L.	Aesth. ENG (REU)	jefflackey@ncdot.gov			✓			✓				
Jeff Lackey JODY K.				phone ✓								
Paul Marak												
Jose Martinez	NCDOT - Signing & Delineation Unit	jgmartinez@ncdot.gov				✓						

Roadside

WEDNESDAY, June 6, 2018			8:00 a.m.	8:30 a.m.	9:30 a.m.	10:00 a.m.	10:30 a.m.	11:00 a.m.	1:00 p.m.	1:30 p.m.	2:00 p.m.	3:30 p.m.
Name	**Representing**	**Email Address / Phone Number**	Recap of Day 1	Earthwork, Drainage, Pavement, Roadway, Geotechnical	Environmental / Permitting / Mitigation	Traffic Control, Signing, Lighting	Traffic Signals and ITS	Environmental / Permitting / Mitigation	Utilities (wet and dry)	Right of Way	Revisit estimate items, i.e. soft costs as necessary	Review and finalize risk register details
David McHenry												
Norman Medford												
Kevin Moore												
Don Parker	NCDOT - WZTC	daparker@ncdot.gov 919-814-4935				✓						
James Parrish	REV - REST AREA	JParrish@ncdot.gov 707-2928			✓							
Roger Radcliff												
Reece Schuler	ROW - VM								✓			
Greg Sealy												
Natasha Simmons	HNTB - Signals/ITS	nsimmons@hntb.com 919-424-0468					✓					
Mark Staley	NCDOT-REU	mstaley@ncdot.gov 919-707-2948			✓							
Paul Stankiewicz	NCDOT REU	PSTANKIEWICZ@NCDOT.GOV			✓							
Sean Ward	R/W									✓ phone		
Mark Whitmore	HNTB	PHONE	✓	✓	✓							
Tim Williams	NCDOT - Signals	tjwilliams@ncdot.gov					✓					
Nicholas Zinser	NCDOT - SIGNALS	rnzinser@ncdot.gov					✓					
Natalie Chan	HNTB	mchan@hntb.com		✓	✓							
Keith Radcliff									✓			

INVITEES / SUBJECT MATTER EXPERTS

FHWA / NCDOT
STIP Nos. I-4400 & I-4700 (I-26 Widening)
Cost Estimate Review
Sign-In Sheet

	THURSDAY, June 7, 2018			TIME / TOPIC	
				8:30 a.m.	9:30 a.m.
	Name	Representing	Email Address / Phone Number	Presentation Dry Run	Closeout Presentation
FHWA	Andrew Callihan	FHWA	andrew.callihan@dot.gov		✓
FHWA	Jim Martin	FHWA	James.Martin@dot.gov		✓
FHWA	Michael Smith	FHWA-RC	michael.smith@dot.gov		✓
FHWA	David Unkefer	FHWA RC			✓
CORE PROJECT TEAM	Ted Adams				
CORE PROJECT TEAM	Wanda Austin	NCDOT	whaustin@ncdot.gov		✓
CORE PROJECT TEAM	Kat Bukowy	HNTB			✓
CORE PROJECT TEAM	Steve Cannon				
CORE PROJECT TEAM	Philip Culpepper	NCDOT, Estimating	pculpepper@ncdot.gov		✓
CORE PROJECT TEAM	Forrest Dungan	NCDOT, Estimating	fmdungan@ncdot.gov		✓
CORE PROJECT TEAM	Jennifer Harris				
CORE PROJECT TEAM	Jeff Hess	HNTB	jhess@hntb.com / 704-208-5363		X
CORE PROJECT TEAM	Donna Keener	HNTB	dckeener@ncdot.gov / 919-707-6637		X
CORE PROJECT TEAM	Karen Lovering	NCDOT - Estimating Mgmt	kmlovering@ncdot.gov (919) 707-6632		✓

	THURSDAY, June 7, 2018			8:30 a.m.	9:30 a.m.
	Name	Representing	Email Address / Phone Number	Presentation Dry Run	Closeout Presentation
CORE PROJECT TEAM	Randy McKinney				
	Brendan Merithew				
	Joe Olson	HNTB	jsolson@hntb.com 919 239 0385	✓	—
	Beverly Robinxon	NCDOT - PMU	brobinsun@ncdot.gov		✓
	Derrick Weaver				
	Bill Zerman	DOT- PMU	bzermane NCDOT.GOV		✓
INVITEES	Brian Burch	via phone NCDOT Div. 14			✓
	Virginia Mabry				
	Jay Swain				
	Chris Werner				
	Joanna Rocco	AECOM (observer) via phone			✓
	Pete Clogston	FHWA via webinar			✓